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ABSTRACT

A workshop was conducted to train local representatives from area vocational-technical schools in Pennsylvania to implement the metric materials developed by the Center for Vocational Education at The Ohio State University. As a result of the workshop, the local representatives were to become part of the dissemination process by supporting other teachers through consultations or conducting local workshops. Participants developed lesson plans to incorporate instruction in metric measurement at the laboratory/shop level to assist local instructors. As a result of participant evaluation it was concluded that the participants exhibited increased awareness of the metric system, developed hands-on competencies in using metric tools, equipment and devices for measurement, and developed skills in the use of conversion tables and for slide rules. (A major portion of the document is comprised of attachments, including the workshop agenda, a handout describing the metric system, instructional packets [learning activities], metric units-common and uncommon, use of metric slide rule, lesson plan samples, metric workshop evaluation, and metric measurement test.)

(JH)

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FINAL REPORT

METRIC MEASUREMENT WORKSHOP FOR VOCATIONAL FACILITATORS

(Project No. 84-8801)

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Schnecksville, Pennsylvania 18078

September, 1978

PENNSYLVANIA DEPARTMENT OF EDUCATION
BUREAU OF VOCATIONAL EDUCATION
RESEARCH COORDINATING UNIT

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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PREFACE

Business, industry and education are effecting the transition from the English to the metric system of measurement in compliance with federal legislation. Vocational education students must be prepared to use equipment and measuring instruments calibrated to the metric system.

The Center for Vocational Education at the Ohio State University has developed materials for metric implementation in vocational programs. Historically, materials distributed to a large audience without adequate orientation to their use have produced minimal impact on instruction in instructor behavior. The alternative to misuse or little use of new materials is to develop and conduct training sessions for implementation of these materials. It is important also to effect this training for the greatest number of people at the lowest possible expenditures of human and monetary resources.

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ABSTRACT

Metric Measurement Workshop for Vocational Facilitators

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\$12,470.00 Federal
7/1/78 to 6/30/79

The purpose of this workshop was to train local representatives from area vocational-technical schools in Pennsylvania to implement the metric materials developed by the Center for Vocational Education at Ohio State University. These local representatives will then become part of the dissemination process by supporting other teachers through consultations or conducting local workshops.

Objectives

The metric measurement workshop for local representatives was designed to accomplish the following:

1. Provide facilitators (local representatives) for vocational-technical schools who are adept in the use of metric measurement.
2. Train facilitators to conduct local metric workshops.
3. Train facilitators to support local instructors in the implementation of metric measures in their instruction.

Outcomes

In meeting the specific objectives of the workshop -

1. Participants exhibited increased awareness of the metric system including the information, knowledge, and skills required in the transition from customary to metric systems.
2. Participants (22 of 24) felt adequately prepared to teach metric measurement. Two (2) felt they could teach metric measurement with additional personal training and review.
3. Participants developed lesson plans to incorporate instruction in metric measurement at the laboratory/shop level to assist local instructors.

The following outcomes were apparent after participant evaluation of the program:

1. A working knowledge of metric precepts as they deal with linear measurement, area, temperature, mass and volume was developed.
2. Hands-on competencies in using metric tools, equipment and devices for measurement were developed in conjunction with the recognition of metric units, terms, symbols and physical referents.
3. Skills in the use of conversion tables and/or slide rules were developed in converting customary to metric equivalents or vice versa.
4. Lesson plans were developed tailored for use in laboratories or shop areas.

Audience

The procedures established for this project would be most useful to administrators, curriculum planners, and teachers charged with the implementation of the metric system in vocational-technical curriculums.

Publications and Available Materials

Final Report

WORKSHOP PROCEDURES

There is a need for teachers of vocational-technical students to promote the use of metric measurement in their instructional programs. The purpose of this workshop was to train local representatives from area vocational-technical schools in Pennsylvania to implement the metric materials developed by the Center for Vocational Education at Ohio State University. These local representatives will then become part of the dissemination process by supporting other teachers through consultations or conducting local workshops.

Objectives:

The metric measurement workshop for local representatives was designed to accomplish the following:

1. Provide facilitators (local representatives) for the vocational-technical schools in the eastern/central regions of Pennsylvania who are adept in the use of metric measurement for vocational education programs.
2. Train facilitators to conduct local metric workshops.
3. Train facilitators to support local instructors in the implementation of metric measures in their instruction.

Procedures:

This workshop provided the means for instructing, assisting and guiding participants from various educational institutions to become acquainted, knowledgeable and skillful in initiating the use of the metric system into vocational curriculums.

The workshop was conducted on Thursday, July 13 - from 9:30 A.M. to 4:00 P.M. and Friday, July 14 - from 8:30 A.M. to 3:00 P.M. There were 25 participants on Thursday, 24 on Friday, (see Participants - Attachment #1). The two six-hour periods of instruction are the minimum required using the developed instructional packets.

The workshop operated in this manner:

- a. First day activities consisted of developing teacher competencies in understanding and using the metric system (see Activity Sheet - Attachment #2). Informational handouts - The Metric System (see Attachment #3) and Why Metric and When? (see Attachment #4) were provided. The history of metric measurement was then reviewed, metric rules explained, a pre-test given, films shown, and instruction in the use of the special metric instructional packet given. Participants then proceeded with hands-on activities which involved rotation among five resource tables where they completed their instructional packet on linear measurement, area, temperature, mass, and volume (see Instructional Packet - Attachment #5). In addition, a set of basic packets for similar measurement exercises, modified to reflect working stations within the existing facility, was provided (see Basic Packet Samples - Attachment #6).

To complete the first phase it was necessary for the Lehigh County Area Vocational-Technical School to have on hand the following:

1. Metric tools and devices (meter sticks, metric rules, metric tapes, conversion slide rules, celsius thermometer, etc.)
 2. Films - a. "Measuring with Meters, or, How to Weigh a Gold Brick with a Meter-Stick"
b. "Meters, Liters, and Grams"
 3. Booklets, pamphlets, metric bibliographies, metric tool and equipment lists, lists of vendors and suppliers (see Attachment #7).
 4. Assorted hardware - measuring tools, temperature devices, containers, measurable items, etc.
 5. Printed materials - worksheets, information sheets, problem sheets, etc.
- b. The major portion of the second day consisted of applying those learned competencies (hands-on experiences) to the development of student lesson plans or learning modules. Other activities included a review quiz on metric measurement (see Reviewing Metric Precepts - Attachment #8) with an informational handout - Metric Units, - Common and Uncommon (see Attachment #9), practice in the use of conversion tables or slide rules (see Use of Metric Slide Rule - Attachment #10), distribution and review of metric packets, and completion of post-test and evaluation forms.

Participants were provided with a set of field tested Metric Packets as developed by the Center for Vocational Education at Ohio State University (CVE-OSU) and supplied for their use by the Research Coordinating Unit (RCU). The packets encompassed metric teaching and learning strategies, objectives, teaching sequences, text, tables, visuals, exercises, tests and references. The occupational areas for which instructional packets were developed included Agri-Business and Natural Resources, Business and Office, Communication Media, Construction, Home Economics, Health Occupations, Manufacturing, Marketing and Distribution, Personal Services, and Transportation. Participants selected one packet representative of their occupational area after which they were to develop a lesson plan for each of the five units in the packet (see Lesson Plan Samples - Attachment #11). Individual lesson plans were reviewed and presentations by participants were made.

Personnel:

The workshop operated with two consultants who had expertise in both the metric system and the use of developed instructional packets peculiar to all trade areas and who were able to instruct, assist, and guide workshop participants to meet workshop objectives. They had attended a workshop for trainers at the Central Westmoreland County Area Vocational-Technical School conducted by the personnel from the Center for Vocational Education at Ohio State University who provided instruction in the use of developed metric packets for all occupational areas. They had also conducted a successful pilot workshop for RCU involving the teaching staff at the Lehigh County Area Vocational-Technical School.

The consultants used various instructional methods and techniques to meet the objectives of the workshop. The entire school facility was made available for use by staff and participants.

Evaluation:

The following instruments developed and furnished by RCU, were used to collect data for determining the effectiveness of the project objectives:

- a. Metric Workshop Evaluation (see Attachment #12) - this instrument collected data on the participant's views toward the organization, facilities, presenters, course materials and films. The second part assessed the participant's level of competency in five metric measurement areas of instruction.
- b. Metric Measurement Test (see Attachment #13) - this instrument measured the participant's knowledge of metric measurement. The 60 items were based on the five units of instruction developed by the Center for Vocational Education - Ohio State University.

FINDINGS AND ANALYSIS

General:

The findings of the workshop were implicit in the examination of the workshops objectives and participant evaluations.

In meeting the objectives of the workshop -

1. A broad representation of educational institutions located in the eastern/central regions of Pennsylvania was evident. Also, the proposal made provision to accommodate a total of four teachers in nonprofit, private schools within the boundaries of this educational agency (two applied and were accepted).

The stated purpose of the workshop was to train local representatives from area vocational-technical schools. Due to a lack of response from this target population, the workshop was opened to other educational institutions. A breakdown of institutions and number of representatives (total 25) is as follows - vocational-technical schools (6), universities (2), colleges (3), community colleges (5), intermediate unit (1), public schools (6), private schools (1), parochial schools (1). This breakdown is important in light of comments made in participant evaluations.

2. The greater majority of workshop participants felt adequately prepared to teach metric measurement based on the training they had received. Twenty-two felt they were adequately prepared while two indicated they could teach metric measurement with additional review and personal training.
3. In addition to the hands-on experiences involved in metric measurement, participants were supplied with metric information necessary to support local instructors - metric bibliographies, equipment and tool lists, instructional material lists, supply lists, vendors lists, etc. More importantly, participants developed lesson plans to incorporate instruction in metric measurement at the laboratory/shop level to assist local instructors.

The following outcomes were acknowledged, in varying degrees, by workshop participants:

1. There was increased awareness of the metric system including the information, knowledge, and skills required in the transition from customary to metric systems.
2. A working knowledge of metric precepts as they deal with linear measurement, area, temperature, mass, and volume was developed.
3. Hands-on competencies in using metric tools, equipment, and devices for measurement were developed.
4. Metric units, terms, symbols, and physical referents were recognized.
5. Skills in the use of conversion tables and/or slide rules were developed in converting customary to metric equivalents or vice versa.
6. Lesson plans were developed tailored for use in laboratories or shop areas.

Evaluation:

Participant response to the workshop was solicited. A copy of the "Metric Workshop Evaluation" sheet showing the summary results of 24 participant evaluations is included as Attachment #14.

Analysis of the four evaluation questions follows:

Question 1 - Participants views toward the organizations, facilities, presenters, course materials and films -

- a. Participants indicated they were highly pleased with the organization of the workshop, adequacy of facilities, course materials and hands-on devices, and quality of films - 75% to 88% of participants rating these segments excellent.
- b. Most participants (63%) rated the quality of the presentations as good, while only 24% rated this segment excellent. An examination of the excellent rating and the evaluation sheets showed that this rating was given by a cross-section of the institutional representatives. The consultants had been rated excellent during presentation of the pilot program. It is felt that the change in the rating was due to the change in the target population of the two programs - AVTS teachers in the pilot program and potential facilitators from various educational institutions in the second.
- c. The adequacy of course content to needs segment drew the greatest comment and the only poor rating of all segments in question 1. An examination of the evaluation sheet showed that the majority of participants rating this segment excellent were representatives of area vocational-technical schools. Good ratings were accompanied, in some cases, by comments that indicated the participants "field" or "major" or "specialty" was not covered, again it is believed, because of the wide diversity of participant positions in institutions represented.

Question 2 - The explanation for the poor comment in question 1 - Quote "Math and science teachers should have more in-depth workshops as to applying metrics to the students in those classrooms, although this workshop did start me thinking metric".

Question 3 - Adequacy of teaching metric - The greater majority of workshop participants felt adequately prepared to teach metric measurement based on the training they had received. Twenty-two (92%) felt they were adequately prepared while two (8%) indicated they could teach metric measurement with additional review and personal training.

Question 4 - Level of competency in working with the five units in the developed metric packets -

- a. Positive levels of competency were indicated with "high" ratings for working with linear, area, temperature, mass and volume measurements (67%), and working with metric to metric equivalents (58%).
- b. A majority of ratings were rated "high" for the segments dealing with selecting and using metric instruments, tools and devices; and working with conversion tables or slide rules (46%). However, (54%) of participants rated these segments as average or low. Comments lead us to believe that several factors were in force - participant positions in institutions represented and insufficient workshop time allowance for these segments.
- c. The indication of level of competency for the Metrics in Your Occupation segment parallels the comments given to question 1 - Adequacy of Course Content to Needs. The comments noted by the participants are basically the same expressed in the analysis of question 1, part c. An examination of the evaluation sheets however, indicated that not all participants who rated "adequacy of course content needs" excellent, good, fair, poor - were the same individuals that rated "metrics in your occupation" - high, average, low, N.A. - although the number of participants indicated on the summary sheet are identical.

The RCU Metric Measurement Test was used as a pre-test before the hands-on experiences of the first day activities and as a post-test at the end of second day activities. The test measured the participants knowledge of metric measurement and the 60 items were based on the five units of metric instruction. The results of these tests are noted below:

	Pre-test		Post-test	
	No. Wrong	Percent	No. Wrong	Percent
Participant				
#1	10	83%	7	88%
#2	24	60%	5	92%
#3	5	92%	3	95%
#4	10	83%	2	97%

Participant	Pre-test		Post-test	
	No. Wrong	Percent	No. Wrong	Percent
#5	23	62%	9	85%
#6	11	82%	-	-
#7	32	47%	11	82%
#8	41	32%	14	77%
#9	22	63%	2	97%
#10	9	85%	7	88%
#11	17	72%	3	95%
#12	7	88%	4	93%
#13	36	40%	22	63%
#14	37	38%	3	95%
#15	33	45%	2	97%
#16	6	90%	3	95%
#17	39	35%	17	72%
#18	4	93%	3	95%
#19	51	15%	10	83%
#20	10	83%	5	92%
#21	34	43%	8	87%
#22	17	72%	5	92%
#23	14	77%	7	88%
#24	24	60%	6	90%
#25	14	77%	2	97%

Average Score = 65%
 Mean - 17 = 72%
 Mode - 10 = 83%

89%
 5 = 92%
 3 = 95%

CONCLUSIONS AND RECOMMENDATIONS

The following are participant comments in regard to this workshop:

1. Hands-on experiences were excellent.
2. Workshop organization and facilities were of the highest quality.
3. Thank you for presenting such a well organized, informative workshop. This is probably the best workshop on any topic I have attended. Your attention to details (such as motel arrangements, clear and concise maps, specific signs to parking areas, etc.) is appreciated.
4. Thoroughly enjoyed the workshop.
5. I was fearful of metrics but now I feel knowledgeable with a lot of information on how I can expand this knowledge.
6. An excellent workshop.
7. I for one am most grateful for this opportunity (to attend this workshop).
8. Stimulating workshop with a good balance of lecture and hands-on tasks.
9. I had no prior knowledge of metrics and feel now that I have a good grasp of the subject.
10. I found this workshop to be very good. Well done!
11. The workshop was excellent in that although several people participating had OBVIOUSLY had some background in its use, the workshop was conducted assuming we are all new to the concept.
12. Nice job. Thanks for having me.

The following are participant concerns, and in essence recommendations, in regard to this workshop:

1. Use other teaching techniques such a role playing (during presentations).
2. Divide the group after the pre-test by level of understanding of the concept.
3. Recommend more preliminary instruction should be provided prior to hands-on experiences.
4. Recommend more depth to the study of metrics, however, I understand that this was not the objective of this particular workshop.
5. Would have enjoyed more in-depth instruction in some of the technical aspects of the metric system - however, I realize the workshop was limited to basic metric instruction.
6. Need more than two days to become familiar with metric system.

7. One day longer would be better in terms of clinching metrics and working with the metric system.
8. Need to develop construction trades area (metric packets).

From the comments and concerns expressed, several conclusions can be drawn.

1. Many participant concerns dealt with the "time factor" in one manner or another. Recommendations varied from adding a day to the workshop, restructuring the content of the workshop, or reallocating the time allowed for various segments of the workshop. Thought should be given to an increased time allotment in future workshops. If this is not possible, the time span for various segments of the workshop should be reallocated to provide more time in those segments dealing with metric concepts, especially the units dealing with selection of metric instruments and working with conversion tables.
2. It might be well to consider some sort of "homogeneous" grouping at future workshops. Several recommendations were made in this area. This could occur by conducting separate workshops for those familiar and unfamiliar with the metric system, or grouping the participants after the results of the pre-test became known. This disparity of experience was quite evident in the various segments of the hands-on phase when it was obvious that this was the first experience with metrics for many of the participants. This arrangement would also accommodate those requesting more in-depth study of metrics.
3. The request for more preliminary instruction prior to the hands-on experiences or incorporating different teaching techniques can be accomplished in the re-allocation of the time segments for teaching the metric concepts. This recommendation deals again with the "time factor" previously discussed.

Personnel of the Lehigh County Area Vocational-Technical School were happy to cooperate with the RCU in providing this workshop to train local facilitators for the area vocational-technical schools of this region.

ATTACHMENTS

1. Participants
2. Activity Sheet
3. The Metric System
4. Why Metric and When?
5. Instructional Packet
6. Basic Packet Samples
7. Metric Bibliographies
8. Reviewing Metric Precepts
9. Metric Units - Common and Uncommon
10. Use of Metric Slide Rule
11. Lesson Plan Samples
12. Metric Workshop Evaluation
13. Metric Measurement Test
14. Metric Workshop Evaluation (Summary - 24 Participants)

LEHIGH COUNTY VOCATIONAL-TECHNICAL SCHOOL

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July 12, 1978
Revised July 13, 1978

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Research Coordinating Unit (R.C.U.) Metric Measurement Program

Activity Sheet

Location: Lehigh County Vocational-Technical School
2300 Main Street
Schnecksville, PA 18078

Thursday - July 13, 1978 (Day I)

9:00 - 9:30 AM - Registration (in Cafetorium)

9:30 AM - Welcome

- A. Administrative announcements
- B. Introduction of RCU representative, consultants
- C. Workshop procedure

9:40 AM - Bob Demkovitz

- A. Explanation of Metric Workshop
- B. Objectives and expected outcomes

9:50 AM - Lynn Benninger

- A. Review Metric History
- B. Explanation of Metric Rules
- C. Pre-Test

10:20 AM - Consultants

- A. Instruction on use of instructional packet
- B. Division into groups

10:35 AM - Hands-on Assignments

- A. Review measurement activities
- B. Hands-on assignments (linear measurement, area, volume, mass and temperature)

NOON Lunch

12:30 PM - Continue Hands-on Assignments

2:15 PM - Break

2:25 PM - Continue Hands-on Assignments

3:00 PM - Consultants

- A. Films
 - 1. "Measuring with Meters, or, How to Weigh a Gold Brick with a Meter-Stick"
 - 2. "Meters, Liters, and Grams"
- B. Discussion

3:45 PM - Consultants

- A. Distribute metric packets
- B. Lesson plan assignment
 - 1. Occupational Outcomes
 - 2. Performance Objectives
 - 3. Teaching Sequence
 - 4. Evaluation

4:00 PM - Adjourn First Day Activities

Friday - July 14, 1978 (Day II)

8:00 - 8:30 AM - Sign-In

8:30 AM - Administrative announcements

8:35 AM - Consultants

- A. Review agenda
- B. Review metric precepts - linear measurement, area, temperature, mass and volume
- C. Discussion

9:00 AM - Participants

- A. Group assignment - develop individual lesson plans for metric packet, starting with Unit I.

10:00 AM - Break

10:15 AM - Participants

- A. Presentation of lesson plans - Unit I

11:15 AM - Participants

- A. Group assignment - develop individual lesson plans for remainder of metric packet.

NOON Lunch

12:30 PM - Participants

- A. Continue to develop lesson plans for:
 - Unit 2 - Metrics in this Occupation
 - Unit 3 - Metric-Metric Equivalents
 - Unit 4 - Selecting and Using Metric Instruments
 - Unit 5 - Metric-Customary Equivalents

1:30 PM - Participants

- A. Use of Conversion Slide Rule
- B. Discussion

2:00 PM - Evaluation and Post Test

3:00 PM - Adjourn Workshop

THE METRIC SYSTEM

A BASE 10 (DECIMAL) SYSTEM OF MEASUREMENT

The meter has been a legal unit of length in the U. S. since 1866. In 1963 it was made the fundamental length standard.

In 1960, the *Système International d'Unités* (SI) was adopted by the United States to provide a coherent system of units for scientific and engineering work. It is universal and complete, based on the Meter-Kilogram-Second (MKS) System, with units for all physical quantities. The basic units of the SI are: meter (length), kilogram (mass), second (time), ampere (electric current), kelvin (temperature), mole (quantity of matter), and candela (luminous intensity). Some of many derived units are: newton (force),

joule (work or energy), watt (power), volt (potential difference), hertz (frequency), and lux (illumination). Supplementary units are the radian (angle) and steradian (solid angle). Customary units of weights and measures in the United States are based on the meter and kilogram. The only legal units for electricity and illumination in the United States are SI units. The SI units of power, energy, etc. apply whether they refer to thermal, mechanical, nuclear, or any other kind of quantity.

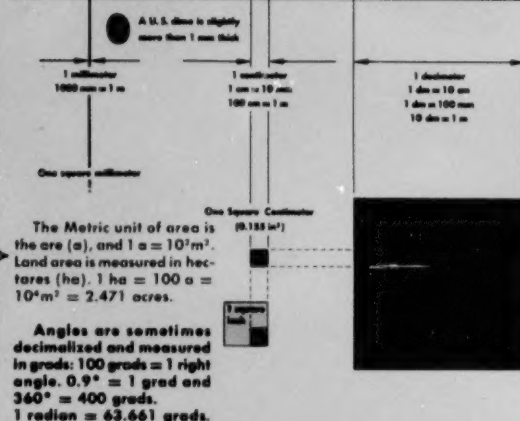
LENGTH

AREA

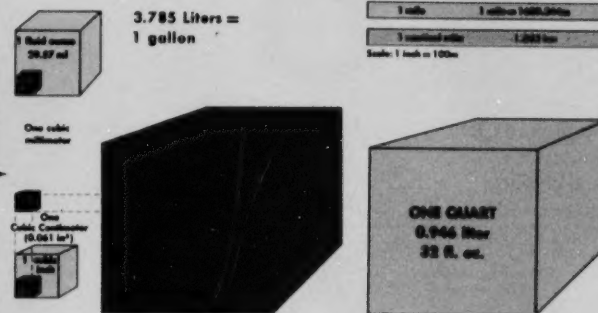
MASS



The meter is approximately 1/10,000,000 of the distance from the North Pole to the equator.



VOLUME



PREFIXES

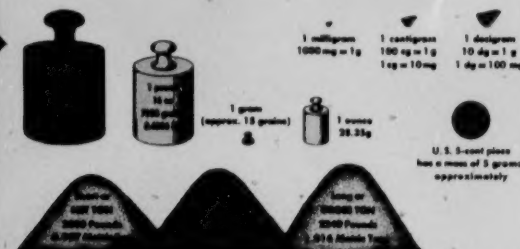
Names of multiples of SI and Metric units are formed by adding a prefix to "meter," "gram," "liter," "watt," or any other unit. Abbreviations use a prefix letter such as "ns" for nanosecond, "kHz" for kilohertz, "mV" for millivolt, etc.

tera-	T	10 ¹²	1 000 000 000 000	one trillion
giga-	G	10 ⁹	1 000 000 000	one billion
mega-	M	10 ⁶	1 000 000	one million
kilo-	k	10 ³	1 000	one thousand
hecto-	h	10 ²	100	one hundred
deka-	da	10 ¹	10	ten
deci-	d	10 ⁻¹	1	one
centi-	c	10 ⁻²	.1	one tenth
milli-	m	10 ⁻³	.001	one thousandth
micro-	μ	10 ⁻⁶	.000 001	one millionth
nano-	n	10 ⁻⁹	.000 000 001	one billionth
pico-	p	10 ⁻¹²	.000 000 000 001	one trillionth
femto-	f	10 ⁻¹⁵	.000 000 000 000 001	one quadrillionth
atto-	a	10 ⁻¹⁸	.000 000 000 000 000 001	one septillionth

STANDARDS

Since 1866 the kilogram has been a legal unit of mass in the U. S. In 1893 the kilogram was made the fundamental mass standard. On July 1, 1959 the following relationship was adopted for other mass units: 1 pound = 0.45359237 kilogram (*avoirdupois*).

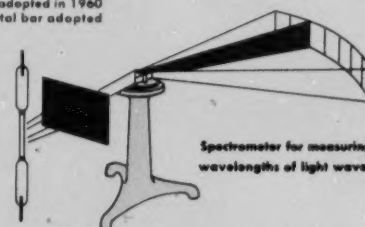
The Metric unit of force, the *newton* (N), is the force that will give a mass of 1 kg an acceleration of 1 m s⁻². The acceleration due to gravity is approximately 9.8 m s⁻².



The International Standard Meter is defined as 1,650,763.73 times the wavelength of the orange-red line in the spectrum of krypton 86. This standard was adopted in 1960 and replaces a metal bar adopted in 1875.

International Length Standard
0.605780210 μm

Discharge tube containing Krypton 86 gas



Spectrometer for measuring wavelengths of light waves

Standard kilogram mass:
A platinum-iridium cylinder



The International Kilogram Mass is kept at the International Bureau of Weights and Measures established in 1875 at Sèvres, France. The United States Customary Kilogram is derived from a prototype kept at the National Bureau of Standards in Washington, D. C.

TIME

TEMPERATURE

ELECTRIC CURRENT

LUMINOUS INTENSITY

QUANTITY OF MATTER

The second (s) is the basic unit of time and is defined as the duration of 9,192,631,770 complete vibrations of simulated radiation from an isotope of Cesium (Cs 133). The second is approximately 1/86,400 part of a mean solar day. Standard frequencies are broadcast from short-wave radio station WWV at 2.5, 5, 10, 15, 20, and 25 MHz.

The Celsius temperature scale is used with the Metric System. It is based on the temperature of the boiling point of water at 100°C and the triple point of water at 0.01°C. The Celsius scale is derived from the thermodynamic or Kelvin scale which has its zero point at absolute zero, the triple point at 273.16 kelvins, and the boiling point at 373.15 K.

The basic electrical unit, the *ampere* (A), is defined as the current which when flowing through each of two long parallel wires separated by 1 m in space, results in a force of 2 x 10⁻⁷ newton (N) between the wires for each meter of their length. Other electrical units such as the volt (V), and ohm (Ω), are derived from the ampere.

The *candela* (cd) is the luminous intensity of 6 x 10⁻⁸ m² of freezing platinum at 2042°K. A source having an intensity of 1 cd when viewed from any and all directions, illuminates a surface of 1 m² at a distance of 1 meter with 1 lux.

The *mole* (mol) is the basic unit for the quantity of matter and is defined as the amount of substance of a system containing as many elementary entities as there are atoms in 0.012 kg of carbon-12.

CAT. NO. 0148-81

Attachment #3

SI and METRIC EQUIVALENTS

LENGTH

inch	25.4	mm	(millimeters)
foot	305	mm	(millimeters)
yard	0.914	m	(meter)
mile	1.61	km	(kilometers)
nautical mile	1.85	km	(kilometers)
mil	25.4	μm	(micrometers)

AREA

square inch	645	mm^2	(square millimeters)
square foot	0.0929	m^2	(square meter)
square yard	0.836	m^2	(square meter)
square mile	2.59	km^2	(square kilometers)
acre	4050	m^2	(square meters)
circular mil	0.000507	mm^2	(square millimeter)

VOLUME

cubic inch	16,400	mm^3	(cubic millimeters)
cubic foot	0.0283	m^3	(cubic meter)
cubic yard	0.765	m^3	(cubic meter)

CAPACITY

fluid ounce	29,600	mm^3	(cubic millimeters)
teaspoon	4930	mm^3	(cubic millimeters)
tablespoon	14,800	mm^3	(cubic millimeters)
cup	0.000237	m^3	(cubic meter)
pint	0.000473	m^3	(cubic meter)
quart	0.000946	m^3	(cubic meter)
gallon	0.00379	m^3	(cubic meter)
fifth	0.000758	m^3	(cubic meter)
peck	0.00881	m^3	(cubic meter)
bushel	0.0352	m^3	(cubic meter)

MASS

ounce	28.4	g	(grams)
pound	454	g	(grams)
ton (short)	907	kg	(kilograms)
ton (long)	1002	kg	(kilograms)

VELOCITY

inches per second	25.4	mm s^{-1}	(millimeters per second)
feet per second	0.305	m s^{-1}	(meter per second)
miles per hour	0.447	m s^{-1}	(meter per second)
knots	0.515	m s^{-1}	(meter per second)

ACCELERATION

feet per second per second	0.305	m s^{-2}	(meter per second per second)
miles per hour per second	0.447	m s^{-2}	(meter per second per second)

FORCE

poundal	0.138	N	(newton)
pound	4.45	N	(newtons)
ton	8.86	kN	(kilonewtons)

PRESSURE

pounds per square inch	6880	N m^{-2}	(newtons per square meter)
pounds per square foot	47.8	N m^{-2}	(newtons per square meter)
inches of mercury (STP)	3380	N m^{-2}	(newtons per square meter)

WORK

foot pound	1.36	J	(joules)
foot poundal	0.042	J	(joule)

POWER

foot pounds per second	1.36	W	(watts)
horsepower	746	W	(watts)

HEAT

British thermal unit (Btu)	1.060	kJ	(kilojoules)
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TEMPERATURE

one degree Fahrenheit	0.555	K	(kelvin)
degrees Fahrenheit [$0.555 (^\circ\text{F}-32) + 273$]		K	(kelvin)

WHY METRIC AND WHEN?

WORLDWIDE AND U.S. METRICATION

The metric system is simple, logical and easy to understand. Learning it is not difficult. Few of us will reap the glee which a Charlie Brown character has portrayed in the comics--"two grams equal one grampa" or "if I see a centimetre coming into the room, I'll step on it."

Information on world-wide and U.S. metrication is useful to develop a sense of the timing and pacing of the metric changeover.

ALL INDUSTRIALIZED NATIONS HAVE CHANGED TO THE METRIC SYSTEM OR ARE ALREADY DOING SO.

Because of problems in world trade, during the 1960's, many countries met to develop a worldwide system of measurement. Even the metric countries were using different measurements and sizes in manufacturing screws, parts, and other products.

The metric system was selected as a worldwide system because it is a decimal system--based on tens--like our number system and our money. With a little practice, it is easier to use, simpler, faster, and people do not make as many mistakes.

The old metric system was brought up to date and made simpler. The new metric system is called the International System of Units (S.I.).

Among the last countries to change to the metric system are: Great Britain (1965-75), Australia (1970-80), New Zealand (1969-76), Canada (1974-79), and the United States.

Canada. In 1975, Canada began reporting temperature, and rainfall and snowfall in metric units; clinical thermometers were changed; some pet food and biscuit packages were changed; two of the six sugar refiners began to package sugar in 1 kg, 2 kg, 4 kg, 10 kg, and 40 kg packages. Changes planned

for 1976 include: newsprint and paper pulp in metric by request, all sugar packaging, the Montreal Olympics, snack foods in metric packages, the show industry, Quebec's dairy industry, and atmospheric pressure in kilopascals. By 1977, metric units will be used for automobile speedometers; all grain sales, distance, visibility, and windspeed reports; textile orders; speed limit and highway signs; and all "new" wine. In 1978 retail food will be measured on metric scales. In 1979 lumber products will be shipped in metric sizes. Canada expects that most of the change to metric will be made by 1977-78--including building products, paint, and consumer goods.

U.S. METRICATION

U.S. INDUSTRIES HAVE BEEN CHANGING TO THE METRIC SYSTEM.

Many U.S. companies have changed to metric-sized products in order to trade with other countries. Our trade with other countries amounts to more than 110 billion dollars each year. Many of the things we trade are measurement sensitive.

Pharmaceutical companies changed most of their products to metric about 20 years ago. Doctors, nurses, pharmacists, and medical and dental technicians are already using many metric measures.

U.S. companies which make automobiles and trucks, earth-moving and agricultural equipment, business machines and machine tools have been changing. Most new designs are in metric--the Ford Pinto engine; General Motor's Cadillac Seville, Caterpillar Tractors, International Harvester equipment, Honeywell products, and others.

THE RATE OF CHANGE TO METRIC IS SPEEDING UP. WORLD WIDE AND U.S. CHANGEOVER IS CREATING A "SNOWBALL" EFFECT.

Machine tool companies, steel producers, makers of nuts and bolts, and other suppliers have been quick to supply U.S. manufacturers metric-sized

tools and products. In 1975, U.S. Steel and Bethlehem Steel began to Supply metric-sized products.

Because we exchange many goods with Canada, some U.S. manufacturers plan to change to metric sizes when Canada changes. The U.S. metric planning committees for paint manufacturing, and lumber and wood products recommend changing to metric sizes in 1978-79, at the same time Canada makes the change. U.S. textile manufacturers are also coordinating their planning with Canadian manufacturers. The nine European Economic Community countries will require all products imported after 1977 to be labeled in metric, or produced and labeled in metric sizes. Some U.S. industries will change to metric sizes soon, rather than change to metric labeling; then change to metric sizes.

Many companies plan to convert to the metric system. These include:

A.B. Dick, Allis-Chalmers, Armco Steel, Brown and Sharpe (machine tools) Caterpillar Tractor, Chrysler, Clark Equipment, Coca-Cola, Dow-Corning, Ford, General Motors, General Tire and Rubber, Hewlett-Packard (electronics), New England Medical Center Hospital, Rockwell International, Sears, Seven-Up, BM, and Xerox.

GM had planned to introduce their first metric car in 1978, but rushed the newly designed Seville into production in 1975. The Chevette is also a metric car. GM plans to change completely to metric by 1982--including relabeling replacement parts in metric sizes.

Many U.S. workers are using the metric system or are learning on the job-- designers and draftsmen, tool and die makers, machine tool operators, assemblers, inspectors, office personnel, advertising and sales workers, and shipping and receiving clerks. New labor contracts often say that the company will supply workers with the metric tools they need.

Retail stores such as J.C. Penny and Sears have metric planning committees and have metric training materials for their workers, and teachers and consumers.

The national Bureau of Standards has a metric Information Office which is helping with the change. The National Aeronautics and Space Administration uses metric units in their reports. The Maritime Administration will change the merchant marine to the metric system by 1980.

In 1975, The Department of Defense said they will use the metric system whenever practical and consider it in all purchases of supplies and services especially for newly-designed materials. Business which contract with the government will probably want to change as soon as possible to get the business.

Many other government agencies plan to change to the metric system.

In 1975, U.S. industry agreed with the International Standards Organization on a new system of metric bolts and nuts. U.S. Industry will probably change to metric sizes more quickly now.

A U.S. Metric Bill was passed in December, 1975. It says that the nation is changing to metric, and provides a national committee to help plan the changeover.

MANY STATES ALREADY HAVE PLANS FOR METRIC EDUCATION IN THEIR SCHOOLS.

MANY TEACHERS AND STUDENTS ARE LEARNING THE METRIC SYSTEM.

In 1975 Congress established a Metric Education Office in the Office of Education and approved spending up to 10 million dollars each year until 1978, to help prepare teachers and students to use the metric system.

At least 32 states plan to change to the metric system in their schools. Many school districts have metric coordinators. Several are training teachers and students in the metric system. Some states have set dates for beginning or completing the change to the metric system in their schools. Beginning in

1976, California, Oregon, Texas and Arizona say that new textbooks must contain mostly metric measurement. California says the metric system will become the "primary system" of measurement taught and used in the schools. Metric education began in their school in 1975-76 for grades 7 - 12. By 1979-80 it is to be the "first language" of measurement for grades K - 6. And, by 1980-81 they say that only metric measurement will be used in their schools. Many other states have similar plans.

TEACHING AND LEARNING THE METRIC SYSTEM

This metric instructional package was designed to meet job-related metric measurement needs of students. To use this package students should already know the occupational terminology, measurement terms, and tools currently in use. These materials were prepared with the help of experienced vocational teachers, reviewed by experts, tested in classrooms in different parts of the United States, and revised before distribution.

Each of the five units of instruction contains performance objectives, learning activities, and supporting information in the form of text, exercises, and tables. In addition, suggested teaching techniques are included. At the back of this package are objective-based evaluation items, a page of answers to the exercises and tests, a list of metric materials needed for the activities, references, and a list of suppliers.

Classroom experiences with this instructional package suggest the following teaching-learning strategies:

1. Let the first experiences be informal to make learning the metric system fun.
2. Students learn better when metric units are compared to familiar objects. Everyone should learn to "think metric." Comparing metric units to customary units can be confusing.
3. Students will learn quickly to estimate and measure in metric units by "doing."
4. Students should have experience with measuring activities before getting too much information.
5. Move through the units in an order which emphasizes the simplicity of the metric system (e.g., length to area to volume).
6. Teach one concept at a time to avoid overwhelming students with too much material.

Unit 1 is a general introduction to the metric system of measurement which provides informal, hands-on experiences for the students. This unit enables students to become familiar with the basic metric units, their symbols, and measurement instruments; and to develop a set of mental references for metric values. The metric system of notation also is explained.

Unit 2 provides the metric terms which are used in this occupation and gives experience with occupational measurement tasks.

Unit 3 focuses on job-related metric equivalents and their relationships.

Unit 4 provides experience with recognizing and using metric instruments and tools in occupational measurement tasks. It also provides experience in comparing metric and customary measurement instruments.

Unit 5 is designed to give students practice in converting customary and metric measurements. Students should learn to "think metric" and avoid comparing customary and metric units. However, skill with conversion tables will be useful during the transition to metric in each occupation.

Using These Instructional Materials

This package was designed to help students learn a core of knowledge about the metric system which they will use on the job. The exercises facilitate experiences with measurement instruments, tools, and devices used in this occupation and job-related tasks of estimating and measuring.

This instructional package also was designed to accommodate a variety of individual teaching and learning styles. Teachers are encouraged to adapt these materials to their own classes. For example, the information sheets may be given to students for self-study. References may be used as supplemental resources. Exercises may be used in independent study, small groups, or whole-class activities. All of the materials can be expanded by the teacher.

Gloria S. Cooper
Joel H. Magisos
Editors

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UNIT 1

SUGGESTED TEACHING SEQUENCE

1. These introductory exercises may require two or three teaching periods for all five areas of measurement.
2. Exercises should be followed in the order given to best show the relationship between length, area, and volume.
3. Assemble the metric measuring devices (rules, tapes, scales, thermometers, and measuring containers) and objects to be measured.*
4. Set up the equipment at work stations for use by the whole class or as individualized resource activities.
5. Have the students estimate, measure, and record using Exercises 1 through 5.
6. Present information on notation and make Table 1 available.
7. Follow up with group discussion of activities.

*Other school departments may have devices which can be used. Metric supplies are listed in the reference section.

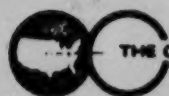
OBJECTIVES

The student will demonstrate these skills for the Linear, Area, Volume or Capacity, Mass, and Temperature Exercises, using the metric terms and measurement devices listed here.

SKILLS	EXERCISES				
	Linear (pp. 3 - 4)	Area (pp. 5 - 6)	Volume or Capacity (pp. 7 - 8)	Mass (pp. 9 - 10)	Temperature (p. 11)
1. Recognize and use the unit and its symbol for:	millimetre (mm)	square centimetre (cm ²)	cubic centimetre (cm ³)	gram (g)	degree Celsius (°C)
2. Select, use, and read the appropriate measuring instruments for:	centimetre (cm)		cubic metre (m ³)	kilogram (kg)	
	metre (m)	square metre (m ²)	litre (l)		
3. State or show a physical reference for:			millilitre (ml)		
4. Estimate within 25% of the actual measure	height, width, or length of objects	the area of a given surface	capacity of containers	the mass of objects in grams and kilograms	the temperature of the air or a liquid
5. Read correctly	metre stick, metric tape measure, and metric rulers		measurements on graduated volume measuring devices	a kilogram scale and a gram scale	A Celsius thermometer

RULES OF NOTATION

1. Symbols are not capitalized unless the unit is a proper name (mm *not* MM).
2. Symbols are not followed by periods (m *not* m.).
3. Symbols are not followed by an s for plurals (25 g *not* 25 gs).
4. A space separates the numerals from the unit symbols (4 l *not* 4l).
5. Spaces, not commas, are used to separate large numbers into groups of three digits (45 271 km *not* 45,271 km).
6. A zero precedes the decimal point if the number is less than one (0.52 g *not* .52 g).
7. Litre and metre can be spelled either with an -re or -er ending.



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METRIC UNITS, SYMBOLS, AND REFERENTS

Quantity	Metric Unit	Symbol	Useful Referents
Length	millimetre	mm	Thickness of dime or paper clip wire
	centimetre	cm	Width of paper clip
	metre	m	Height of door about 2 m
	kilometre	km	12-minute walking distance
Area	square centimetre	cm ²	Area of this space 
	square metre	m ²	Area of card table top
	hectare	ha	Football field including sidelines and end zones
Volume and Capacity	millilitre	ml	Teaspoon is 5 ml
	litre	l	A little more than 1 quart
	cubic centimetre	cm ³	Volume of this container 
	cubic metre	m ³	A little more than a cubic yard
Mass	milligram	mg	Apple seed about 10 mg, grain of salt, 1 mg
	gram	g	Nickel about 5 g
	kilogram	kg	Webster's Collegiate Dictionary
	metric ton (1 000 kilograms)	t	Volkswagen Beetle

METRIC PREFIXES

Multiples and Submultiples	Prefixes	Symbols
1 000 000 = 10 ⁶	mega (mĕg'ā)	M
1 000 = 10 ³	kilo (kĭl'ō)	k
100 = 10 ²	hecto (hĕk'tō)	h
10 = 10 ¹	deka (dĕk'ā)	da
Base Unit 1 = 10 ⁰		
0.1 = 10 ⁻¹	deci (dĕs'ī)	d
0.01 = 10 ⁻²	centi (sĕn'tī)	c
0.001 = 10 ⁻³	milli (mĭl'ī)	m
0.000 001 = 10 ⁻⁶	micro (mĭ'krō)	μ

Table 1-b



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Table 1-a

LINEAR MEASUREMENT ACTIVITIES

Metre, Centimetre, Millimetre

I. THE METRE (m)

A. DEVELOP A FEELING FOR THE SIZE OF A METRE

1. Pick up one of the metre sticks and stand it up on the floor. Hold it in place with one hand. Walk around the stick. Now stand next to the stick. With your other hand, touch yourself where the top of the metre stick comes on you.



THAT IS HOW HIGH A METRE IS!

2. Hold one arm out straight at shoulder height. Put the metre stick along this arm until the end hits the end of your fingers. Where is the other end of the metre stick? Touch yourself at that end.



THAT IS HOW LONG A METRE IS!

3. Choose a partner to stand at your side. Move apart so that you can put one end of a metre stick on your partner's shoulder and the other end on your shoulder. Look at the space between you.



THAT IS THE WIDTH OF A METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN METRES

Now you will improve your ability to estimate in metres. Remember where the length and height of a metre was on your body.

For each of the following items:

Estimate the size of the items and write your estimate in the **ESTIMATE** column. Measure the size with your metre stick and write the answer in the **MEASUREMENT** column.

Decide how close your estimate was to the actual measure. If your estimate was within 25% of the actual measure you are a "Metric Marvel."

	Estimate (m)	Measurement (m)	How Close Were You?
1. Height of door knob from floor.	_____	_____	_____
2. Height of door.	_____	_____	_____
3. Length of table.	_____	_____	_____
4. Width of table.	_____	_____	_____
5. Length of wall of this room.	_____	_____	_____
6. Distance from you to wall.	_____	_____	_____



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II. THE CENTIMETRE (cm)

There are 100 centimetres in one metre. If there are 4 metres and 3 centimetres, you write 403 cm [(4 x 100 cm) + 3 cm = 400 cm + 3 cm].

DEVELOP A FEELING FOR THE SIZE OF A CENTIMETRE

1. Hold the metric ruler against the width of your thumbnail. How wide is it? _____ cm
2. Measure your thumb from the first joint to the end. _____ cm
3. Use the metric ruler to find the width of your palm. _____ cm
4. Measure your index or pointing finger. How long is it? _____ cm
5. Measure your wrist with a tape measure. What is the distance around it? _____ cm
6. Use the tape measure to find your waist size. _____ cm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CENTIMETRES

You are now ready to estimate in centimetres. For each of the following items, follow the procedures used for estimating in metres.

	Estimate (cm)	Measurement (cm)	How Close Were You?
1. Length of a paper clip.	_____	_____	_____
2. Diameter (width) of a coin.	_____	_____	_____
3. Width of a postage stamp.	_____	_____	_____
4. Length of a pencil.	_____	_____	_____
5. Width of a sheet of paper.	_____	_____	_____

III. THE MILLIMETRE (mm)

There are 10 millimetres in one centimetre. When a measurement is 2 centimetres and 5 millimetres, you write 25 mm [(2 x 10 mm) + 5 mm = 20 mm + 5 mm]. There are 1 000 mm in 1 m.

A. DEVELOP A FEELING FOR THE SIZE OF A MILLIMETRE

Using a ruler marked in millimetres, measure:

1. Thickness of a paper clip wire. _____ mm
2. Thickness of your fingernail. _____ mm
3. Width of your fingernail. _____ mm
4. Diameter (width) of a coin. _____ mm
5. Diameter (thickness) of your pencil. _____ mm
6. Width of a postage stamp. _____ mm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLIMETRES

You are now ready to estimate in millimetres. For each of the following items, follow the procedures used for estimating in metres.

	Estimate (mm)	Measurement (mm)	How Close Were You?
1. Thickness of a nickel.	_____	_____	_____
2. Diameter (thickness) of a bolt.	_____	_____	_____
3. Length of a bolt.	_____	_____	_____
4. Width of a sheet of paper.	_____	_____	_____
5. Thickness of a board or desk top.	_____	_____	_____
6. Thickness of a button.	_____	_____	_____



AREA MEASUREMENT ACTIVITIES

Square Centimetre, Square Metre

WHEN YOU DESCRIBE THE AREA OF SOMETHING, YOU ARE SAYING HOW MANY SQUARES OF A GIVEN SIZE IT TAKES TO COVER THE SURFACE.

I. THE SQUARE CENTIMETRE (cm^2)

A. DEVELOP A FEELING FOR A SQUARE CENTIMETRE

1. Take a clear plastic grid, or use the grid on page 6.
2. Measure the length and width of one of these small squares with a centimetre ruler.

THAT IS ONE SQUARE CENTIMETRE!

3. Place your fingernail over the grid. About how many squares does it take to cover your fingernail?
_____ cm^2
4. Place a coin over the grid. About how many squares does it take to cover the coin? _____ cm^2
5. Place a postage stamp over the grid. About how many squares does it take to cover the postage stamp?
_____ cm^2
6. Place an envelope over the grid. About how many squares does it take to cover the envelope?
_____ cm^2
7. Measure the length and width of the envelope in centimetres. Length _____ cm; width _____ cm. Multiply to find the area in square centimetres.
_____ cm x _____ cm = _____ cm^2 . How close are the answers you have in 6. and in 7.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE CENTIMETRES

You are now ready to develop your ability to estimate in square centimetres.

Remember the size of a square centimetre. For each of the following items, follow the procedures used for estimating in metres.

	Estimate (cm^2)	Measurement (cm^2)	How Close Were You?
1. Index card.	_____	_____	_____
2. Book cover.	_____	_____	_____
3. Photograph.	_____	_____	_____
4. Window pane or desk top.	_____	_____	_____

II. THE SQUARE METRE (m^2)

A. DEVELOP A FEELING FOR A SQUARE METRE

1. Tape four metre sticks together to make a square which is one metre long and one metre wide.
2. Hold the square up with one side on the floor to see how big it is.
3. Place the square on the floor in a corner. Step back and look. See how much floor space it covers.
4. Place the square over a table top or desk to see how much space it covers.
5. Place the square against the bottom of a door. See how much of the door it covers. How many squares would it take to cover the door? _____ m^2

THIS IS HOW BIG A SQUARE METRE IS!



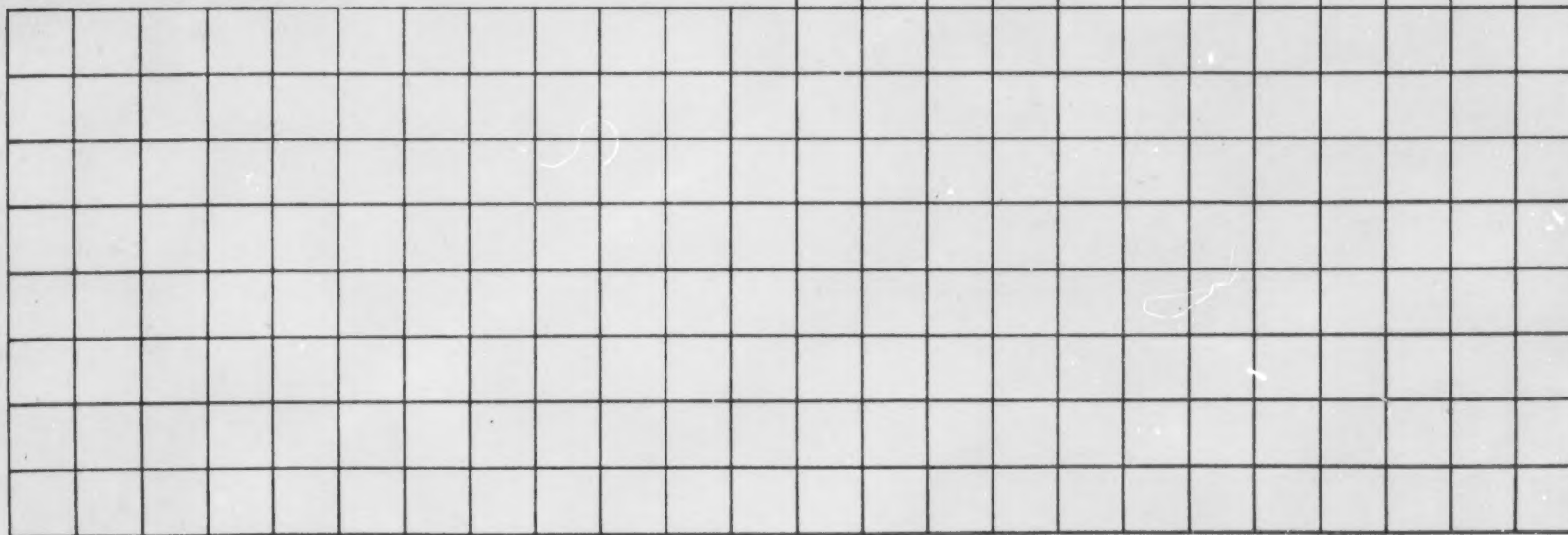
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B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE METRES

You are now ready to estimate in square metres. Follow the procedures used for estimating in metres.

	Estimate (m ²)	Measurement (m ²)	How Close Were You?
1. Door.	_____	_____	_____
2. Full sheet of newspaper.	_____	_____	_____
3. Chalkboard or bulletin board.	_____	_____	_____
4. Floor.	_____	_____	_____
5. Wall.	_____	_____	_____
6. Wall chart or poster.	_____	_____	_____
7. Side of file cabinet.	_____	_____	_____

CENTIMETRE GRID



VOLUME MEASUREMENT ACTIVITIES

Cubic Centimetre, Litre, Millilitre, Cubic Metre

I. THE CUBIC CENTIMETRE (cm³)

A. DEVELOP A FEELING FOR THE CUBIC CENTIMETRE

1. Pick up a colored plastic cube. Measure its length, height, and width in centimetres.

THAT IS ONE CUBIC CENTIMETRE!

2. Find the volume of a plastic litre box.

a. Place a ROW of cubes against the bottom of one side of the box. How many cubes fit in the row? _____

b. Place another ROW of cubes against an adjoining side of the box. How many rows fit inside the box to make one layer of cubes? _____

How many cubes in each row? _____

How many cubes in the layer in the bottom of the box? _____

c. Stand a ROW of cubes up against the side of the box. How many LAYERS would fit in the box? _____

How many cubes in each layer? _____

How many cubes fit in the box altogether? _____

THE VOLUME OF THE BOX IS _____ CUBIC CENTIMETRES.

d. Measure the length, width, and height of the box in centimetres. Length _____ cm; width _____ cm; height _____ cm. Multiply these numbers to find the volume in cubic centimetres.

_____ cm x _____ cm x _____ cm = _____ cm³.

Are the answers the same in c. and d.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC CENTIMETRES

You are now ready to develop your ability to estimate in cubic centimetres.

Remember the size of a cubic centimetre. For each of the following items, use the procedures for estimating in metres.

	Estimate (cm ³)	Measurement (cm ³)	How Close Were You?
1. Index card file box.	_____	_____	_____
2. Freezer container.	_____	_____	_____
3. Paper clip box.	_____	_____	_____
4. Box of staples.	_____	_____	_____

II. THE LITRE (l)

A. DEVELOP A FEELING FOR A LITRE

1. Take a one litre beaker and fill it with water.

2. Pour the water into paper cups, filling each as full as you usually do. How many cups do you fill?

THAT IS HOW MUCH IS IN ONE LITRE!

3. Fill the litre container with rice.

THAT IS HOW MUCH IT TAKES TO FILL A ONE LITRE CONTAINER!



B. DEVELOP YOUR ABILITY TO ESTIMATE IN LITRES

You are now ready to develop your ability to estimate in litres. To write two and one-half litres, you write 2.5 l, or 2.5 litres. To write one-half litre, you write 0.5 l, or 0.5 litre. To write two and three-fourths litres, you write 2.75 l, or 2.75 litres.

For each of the following items, use the procedures for estimating in metres.

	Estimate (l)	Measurement (l)	How Close Were You?
1. Medium-size freezer container.	_____	_____	_____
2. Large freezer container.	_____	_____	_____
3. Small freezer container.	_____	_____	_____
4. Bottle or jug.	_____	_____	_____

III. THE MILLILITRE (ml)

There are 1 000 millilitres in one litre. 1 000 ml = 1 litre. Half a litre is 500 millilitres, or 0.5 litre = 500 ml.

A. DEVELOP A FEELING FOR A MILLILITRE

1. Examine a centimetre cube. Anything which holds 1 cm³ holds 1 ml.
2. Fill a 1 millilitre measuring spoon with rice. Empty the spoon into your hand. Carefully pour the rice into a small pile on a sheet of paper.

THAT IS HOW MUCH ONE MILLILITRE IS!

3. Fill the 5 ml spoon with rice. Pour the rice into another pile on the sheet of paper.

THAT IS 5 MILLILITRES, OR ONE TEASPOON!

4. Fill the 15 ml spoon with rice. Pour the rice into a third pile on the paper.

THAT IS 15 MILLILITRES, OR ONE TABLESPOON!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLILITRES

You are now ready to estimate in millilitres. Follow the procedures used for estimating metres.

	Estimate (ml)	Measurement (ml)	How Close Were You?
1. Small juice can.	_____	_____	_____
2. Paper cup or tea cup.	_____	_____	_____
3. Soft drink can.	_____	_____	_____
4. Bottle.	_____	_____	_____

IV. THE CUBIC METRE (m³)

A. DEVELOP A FEELING FOR A CUBIC METRE

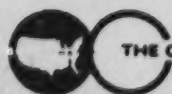
1. Place a one metre square on the floor next to the wall.
2. Measure a metre UP the wall.
3. Picture a box that would fit into that space.

THAT IS THE VOLUME OF ONE CUBIC METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC METRES

For each of the following items, follow the estimating procedures used before.

	Estimate (m ³)	Measurement (m ³)	How Close Were You?
1. Office desk.	_____	_____	_____
2. File cabinet.	_____	_____	_____
3. Small room.	_____	_____	_____



MASS (WEIGHT) MEASUREMENT ACTIVITIES

9

Kilogram, Gram

The mass of an object is a measure of the amount of matter in the object. This amount is always the same unless you add or subtract some matter from the object. Weight is the term that most people use when they mean mass. The weight of an object is affected by gravity; the mass of an object is not. For example, the weight of a person on earth might be 120 pounds; that same person's weight on the moon would be 20 pounds. This difference is because the pull of gravity on the moon is less than the pull of gravity on earth. A person's mass on the earth and on the moon would be the same. The metric system does not measure weight--it measures mass. We will use the term mass here.

The symbol for gram is g.

The symbol for kilogram is kg.

There are 1 000 grams in one kilogram, or $1\ 000\text{ g} = 1\text{ kg}$.

Half a kilogram can be written as 500 g, or 0.5 kg.

A quarter of a kilogram can be written as 250 g, or 0.25 kg.

Two and three-fourths kilograms is written as 2.75 kg.

I. THE KILOGRAM (kg)

DEVELOP A FEELING FOR THE MASS OF A KILOGRAM

Using a balance or scale, find the mass of the items on the table. Before you find the mass, notice how heavy the object "feels" and compare it to the reading on the scale or balance.

Mass
(kg)

- | | | |
|----|-------------------|-------|
| 1. | 1 kilogram box. | _____ |
| 2. | Textbook. | _____ |
| 3. | Bag of sugar. | _____ |
| 4. | Package of paper. | _____ |
| 5. | Your own mass. | _____ |

B. DEVELOP YOUR ABILITY TO ESTIMATE IN KILOGRAMS

For the following items ESTIMATE the mass of the object in kilograms, then use the scale or balance to find the exact mass of the object. Write the exact mass in the MEASUREMENT column. Determine how close your estimate is:

	Estimate (kg)	Measurement (kg)	How Close Were You?
1. Bag of rice.	_____	_____	_____
2. Bag of nails.	_____	_____	_____
3. Large purse or briefcase.	_____	_____	_____
4. Another person.	_____	_____	_____
5. A few books.	_____	_____	_____



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II. THE GRAM (g)

A. DEVELOP A FEELING FOR A GRAM

1. Take a colored plastic cube. Hold it in your hand. Shake the cube in your palm as if shaking dice. Feel the pressure on your hand when the cube is in motion, then when it is not in motion.

THAT IS HOW HEAVY A GRAM IS!

2. Take a second cube and attach it to the first. Shake the cubes in first one hand and then the other hand; rest the cubes near the tips of your fingers, moving your hand up and down.

THAT IS THE MASS OF TWO GRAMS!

3. Take five cubes in one hand and shake them around.

THAT IS THE MASS OF FIVE GRAMS!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN GRAMS

You are now ready to improve your ability to estimate in grams. Remember how heavy the 1 gram cube is, how heavy the two gram cubes are, and how heavy the five gram cubes are. For each of the following items, follow the procedures used for estimating in kilograms.

	Estimate (g)	Measurement (g)	How Close Were You?
1. Two thumbtacks.	_____	_____	_____
2. Pencil.	_____	_____	_____
3. Two-page letter and envelope.	_____	_____	_____
4. Nickel.	_____	_____	_____
5. Apple.	_____	_____	_____
6. Package of margarine.	_____	_____	_____



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Exercise 4

TEMPERATURE MEASUREMENT ACTIVITIES

Degree Celsius

I. DEGREE CELSIUS ($^{\circ}\text{C}$)

Degree Celsius ($^{\circ}\text{C}$) is the metric measure for temperature.

A. DEVELOP A FEELING FOR DEGREE CELSIUS

Take a Celsius thermometer. Look at the marks on it.

1. Find 0 degrees.

WATER FREEZES AT ZERO DEGREES CELSIUS (0°C)

WATER BOILS AT 100 DEGREES CELSIUS (100°C)

2. Find the temperature of the room. _____ $^{\circ}\text{C}$. Is the room cool, warm, or about right?
3. Put some hot water from the faucet into a container. Find the temperature. _____ $^{\circ}\text{C}$. Dip your finger quickly in and out of the water. Is the water very hot, hot, or just warm?
4. Put some cold water in a container with a thermometer. Find the temperature. _____ $^{\circ}\text{C}$. Dip your finger into the water. Is it cool, cold, or very cold?
5. Bend your arm with the inside of your elbow around the bottom of the thermometer. After about three minutes find the temperature. _____ $^{\circ}\text{C}$. Your skin temperature is not as high as your body temperature.

NORMAL BODY TEMPERATURE IS 37 DEGREES CELSIUS (37°C).

A FEVER IS 39°C .

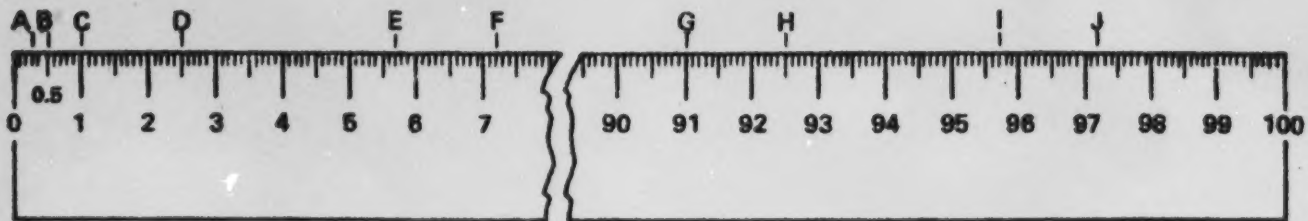
A VERY HIGH FEVER IS 40°C .

B. DEVELOP YOUR ABILITY TO ESTIMATE IN DEGREES CELSIUS

For each item, ESTIMATE and write down how many degrees Celsius you think it is. Then measure and write the MEASUREMENT. See how close your estimates and actual measurements are.

	Estimate ($^{\circ}\text{C}$)	Measurement ($^{\circ}\text{C}$)	How Close Were You?
1. Mix some hot and cold water in a container. Dip your finger into the water.	_____	_____	_____
2. Pour out some of the water. Add some hot water. Dip your finger <u>quickly</u> into the water.	_____	_____	_____
3. Outdoor temperature.	_____	_____	_____
4. Sunny window sill.	_____	_____	_____
5. Mix of ice and water.	_____	_____	_____
6. Temperature at floor.	_____	_____	_____
7. Temperature at ceiling.	_____	_____	_____





There are 100 centimetres in one metre. (100 cm)
 There are 10 millimetres in one centimetre (10 mm)
 or 1000 millimetres in one metre (1000 mm).

The symbol for metre is "m"
 The symbol for centimetre is "cm"
 The symbol for millimetre is "mm"

A is read as 0.3 cm or 3 mm.
 C is read as 1 cm or 10 mm.
 D is read as 2.5 cm or 25 mm.
 E is read as 5.7 cm or 57 mm.
 F is read as 7.2 cm or 72 mm.

B is read as _____ cm or _____ mm.
 G is read as _____ cm or _____ mm.
 H is read as _____ cm or _____ mm.
 I is read as _____ cm or _____ mm.
 J is read as _____ cm or _____ mm.

MEASUREMENT ACTIVITIES LINEAR RESOURCE TABLE

MEASURES OF LENGTH METRE, CENTIMETRE, MILLIMETRE

I. The metre (m)

A. DEVELOP A FEELING FOR HOW LONG A METRE IS

1. Take a metre stick and stand it up on its end on the floor with your hand on top.
2. Keeping your hand on top,
 - a. walk around the metre stick
 - b. stand very close to it and with your other hand touch the part of the body at the top of the stick

THAT IS HOW HIGH A METRE IS!

3. Put one end of the metre stick in your right hand. Stretch that arm straight out to the side. Keep the end of the metre stick even with the end of the longest finger of that hand. With your left hand, press against your body at the other end of the metre stick.

THAT IS HOW LONG A METRE IS!

4. Choose a partner to stand out to your side. Move apart so you can place one end of the metre stick against their upper arm. Look at the space between you. "Feel" how far apart you are.

THAT IS THE DISTANCE OF ONE METRE!

Page 1
 Linear

B. DEVELOP YOUR ABILITY TO GUESSTIMATE

You are now ready to develop your ability to estimate---to make a reasonable guess.

1. Remember where the length of a metre was on your body.

2. For each of the items below;

First, quesstimate the size and write your answer in the Estimate column. Second, measure with your metre stick and write the answer in the Measurement column.

Third, decide how close you were. Check with others in your group. If your estimate is within 25% of the measurement, you are a "METRIC MARVEL".

3. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Height of the stage from the floor	_____	_____	_____
2. Height of sliding doors	_____	_____	_____
3. Length of table	_____	_____	_____
4. Width of table	_____	_____	_____
5. Length of the stage	_____	_____	_____
6. Distance from you to a wall	_____	_____	_____
7. Other _____	_____	_____	_____
8. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH METRES

If you want extra practice try these:

1. Height of a pillar or column in the cafeteria	_____	_____	_____
2. Width of a pillar or column in the cafeteria	_____	_____	_____
3. Distance from a chair to a wall	_____	_____	_____

II. The centimetre (cm)**A. DEVELOP A FEEL" FOR THE SIZE OF A CENTIMETRE**

1. Hold the centimetre ruler against the width of your fingernail. How wide is it? _____ cm

2. Hold the ruler against your thumb from the first joint to the end of your thumb. How long is it? _____ cm

3. Hold the ruler against the width of your palm. How wide is it? _____ cm
4. Hold the ruler against your index or pointing finger. How long is it?
_____ cm
5. Circle the wrist of one hand with the thumb and index finger of the other. Then measure your wrist with a tape measure. What is the circumference or distance around? _____ cm
6. Find your waist size with a tape measure. _____ cm

B. DEVELOP YOUR ABILITY TO GUESSTIMATE

You are now ready to "guesstimate" in centimetres.

1. Remember the size of a centimetre.
2. For each of the items below;

First, guesstimate the size and write your answer in the Estimate column. Second, measure with your metre stick and write the answer in the Measurement column.

Third, decide how close you were. If your estimate is within 25% of the measurement, you are a "METRIC MARVEL."

3. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Length of a paper clip	_____	_____	_____
2. Diameter (width) of a coin	_____	_____	_____
3. Width of a postage stamp	_____	_____	_____
4. Length of the pencil on the table.	_____	_____	_____
5. Width of a sheet of paper	_____	_____	_____
6. Space between two cities on a map	_____	_____	_____
7. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH CENTIMETRES

1. Length of an envelope	_____	_____	_____
2. Width of an envelope	_____	_____	_____
3. Height of a chair seat	_____	_____	_____
4. Thickness of a book	_____	_____	_____
5. Length of a sheet of paper	_____	_____	_____

II. The millimetre (mm)

There are 10 millimetres in 1 centimetre. When a measurement is 2 centimetres and 4 millimetres, you write 24 mm. There are 1000 millimetres in 1 metre.

A. DEVELOP "A FEEL" FOR THE SIZE OF A MILLIMETRE

Using a ruler marked in millimetres, measure:

1. the thickness of a paper clip wire. _____ mm
2. the thickness of your fingernail. _____ mm
3. the width of your fingernail. _____ mm
4. the diameter (width) of a coin. _____ mm
5. the diameter (thickness) of your pencil. _____ mm
6. the width of your palm. _____ mm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLIMETRES

You are now ready to "guesstimate" in millimetres.

1. Remember the size of a millimetre.
2. For each of the items below;

First, guesstimate the size and write your answer in the Estimate column.
Second, measure with your ruler and write the answer in the Measurement column.

Third, decide how close you were. If your estimate is within 25% of the measurement, you are a "METRIC MARVEL."

3. If you have time, find some other things to measure.

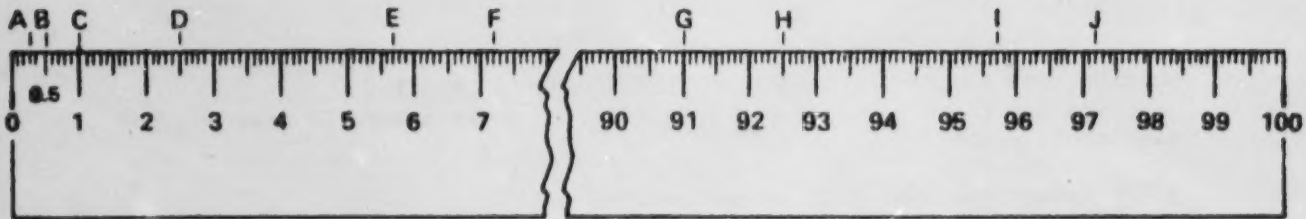
	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Thickness of a nickel	_____	_____	_____
2. Diameter (thickness) of a bolt	_____	_____	_____
3. Length of a bolt	_____	_____	_____
4. Width of a sheet of paper	_____	_____	_____
5. Thickness of a board or desk top	_____	_____	_____
6. Thickness of a button	_____	_____	_____

C. EXTRA PRACTICE WITH MILLIMETRES

1. Length of an envelope _____
2. Width of an envelope _____

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
3. Width of a postage stamp	_____	_____	_____
4. Length of a pencil	_____	_____	_____
5. Thickness of a table	_____	_____	_____

Page 5
Linear



There are 100 centimetres in one metre. (100 cm)
 There are 10 millimetres in one centimetre (10 mm)
 or 1000 millimetres in one metre (1000 mm).

The symbol for metre is "m"
 The symbol for centimetre is "cm"
 The symbol for millimetre is "mm"

A is read as 0.3 cm or 3 mm.
 C is read as 1 cm or 10 mm.
 D is read as 2.5 cm or 25 mm.
 E is read as 5.7 cm or 57 mm.
 F is read as 7.2 cm or 72 mm.

B is read as _____ cm or _____ mm.
 G is read as _____ cm or _____ mm.
 H is read as _____ cm or _____ mm.
 I is read as _____ cm or _____ mm.
 J is read as _____ cm or _____ mm.

AREA RESOURCE TABLE

SQUARE CENTIMETRE, SQUARE METRE

WHEN YOU DESCRIBE THE AREA OF SOMETHING YOU ARE SAYING HOW MANY SQUARES OF A GIVEN SIZE IT WOULD TAKE TO COVER THE SURFACE.

I. The square centimetre (cm²)

A. DEVELOP A FEELING FOR THE SQUARE CENTIMETRE

1. Take a clear plastic grid or use the grid on page 4. (If you use the grid on page 4, place the thing to be measured over the grid and lightly draw its outline with a pencil. Then remove it and count the squares.)
2. Measure the length and width of one small square with a centimetre ruler.

THAT IS ONE SQUARE CENTIMETRE!

3. Place the grid over a fingernail.
About how many squares does it take to cover your fingernail? _____ cm²
4. Place the grid over a coin.
About how many squares does it take to cover the coin? _____ cm²
5. Place the grid over a postage stamp.
About how many squares does it take to cover the postage stamp? _____ cm²
6. Place the grid over an envelope. (You may have to mark the envelope and move the grid to cover all the envelope.)
About how many squares does it take to cover the envelope? _____ cm²
7. Measure the length and width of the envelope with a centimetre ruler.
 Length _____ cm, width _____ cm. Multiply to find the area in square centimetres. _____ cm x _____ cm = _____ cm². How close were the answers you got by counting squares, and then by measuring and multiplying? _____

Page 1
 Area

B. DEVELOP YOUR ABILITY TO GUESSTIMATE IN SQUARE CENTIMETRES

Your are now ready to develop your ability to guesstimate--to make a reasonable guess.

1. Remember the size of a square centimetre.
2. For each of the items below;

First, guesstimate the size and write your answer in the Estimate column.

Second, measure the item either by counting squares on the grid or by measuring and multiplying. Write your answer in the Measurement column.

Third, decide how close you were. If your Estimate is within 25% of the measurement, you are a "METRIC MARVEL."

3. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Index card	_____	_____	_____
2. Book cover	_____	_____	_____
3. Photograph	_____	_____	_____
4. Window pane or desk top	_____	_____	_____
5. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH SQUARE CENTIMETRES

1. Watch	_____	_____	_____
2. Notebook cover	_____	_____	_____
3. Napkin or tissue	_____	_____	_____
4. Small piece of cloth, plastic or leather	_____	_____	_____

WOULD YOU WANT TO FIND THE AREA OF A FLOOR, WALL, ROOF, LAWN OR LARGE PIECE OF MATERIAL BY COUNTING CENTIMETRE SQUARES?

Discuss with your neighbor.

II. The square metre (m^2)

A. DEVELOP A FEELING FOR THE SQUARE METRE

1. Using metre sticks, paper or cardboard, tape them together to make a square which is one metre long and one metre wide. Or, use a square which has been made.

Page 2
Area

2. Hold the square up with one edge on the floor to see how big it is next to you.
3. Place the square over a table top or desk to see how much it covers.
4. Place the square against the bottom or top of a door. See how much it covers. How many does it take to cover the door? _____ m^2
5. Place the square on the floor in a corner or next to a wall. Step back and look.
See how much it covers.

THAT IS HOW BIG A SQUARE METRE IS!

B. DEVELOP YOUR ABILITY TO GUESSTIMATE WITH SQUARE METRES
You are now ready to guesstimate in square metres.

1. Remember the size of a square metre.
2. For each of the items below;

First, guesstimate the size and write your answer in the Estimate column.

Second, measure the item. Write your answer in the Measurement column.
Third, decide how close you were. If your Estimate is within 25% of the Measurement, you are a "METRIC MARVEL."

3. If you have time, find some other things to measure.

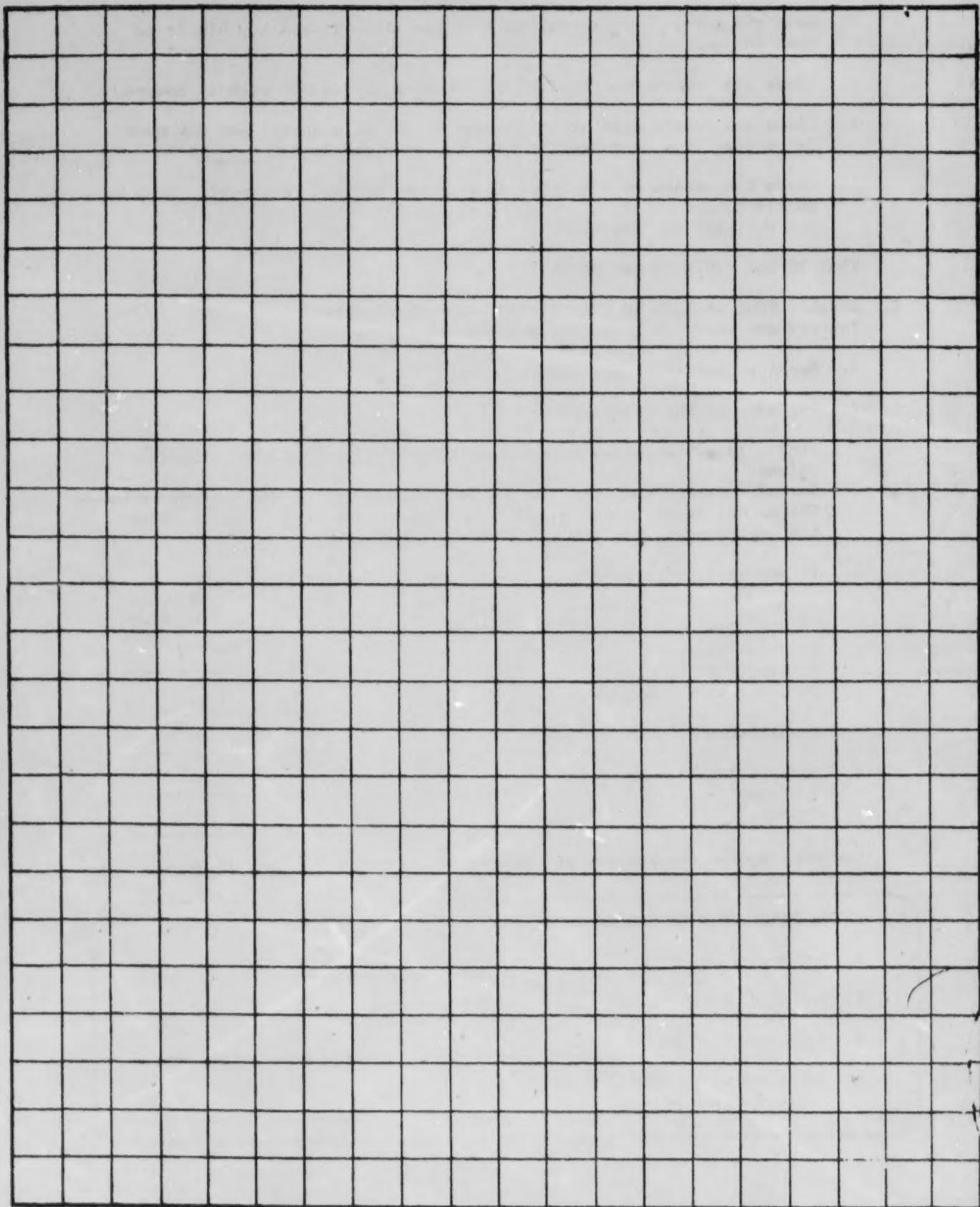
	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Sliding door of cafeteria	_____	_____	_____
2. Full sheet of newspaper	_____	_____	_____
3. Chalk board	_____	_____	_____
4. Side of a pillar or column	_____	_____	_____
5. Other _____	_____	_____	_____

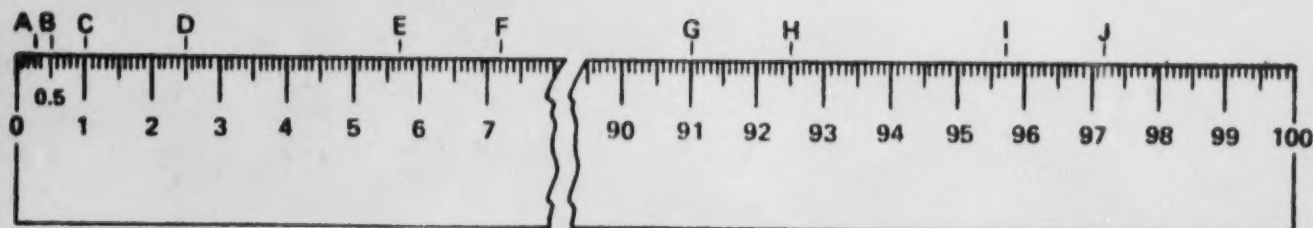
How many square centimetres are in one square metre? _____

C. EXTRA PRACTICE WITH SQUARE METRES

1. Table	_____	_____	_____
2. Front of stage	_____	_____	_____
3. Wall chart or poster	_____	_____	_____
4. Large piece of cloth, paper, plastic, or plywood	_____	_____	_____

Centimetre Grid





There are 100 centimetres in one metre. (100 cm)
 There are 10 millimetres in one centimetre (10 mm)
 or 1000 millimetres in one metre. (1000 mm)

The symbol for metre is "m"
 The symbol for centimetre is "cm"
 The symbol for millimetre is "mm"

A is read as 0.3 cm or 3 mm.

C is read as 1 cm or 10 mm.

D is read as 2.5 cm or 25 mm.

E is read as 5.7 cm or 57 mm.

F is read as 7.2 cm or 72 mm.

B is read as _____ cm or _____ mm.

G is read as _____ cm or _____ mm.

H is read as _____ cm or _____ mm.

I is read as _____ cm or _____ mm.

J is read as _____ cm or _____ mm.

VOLUME RESOURCE TABLE

CUBIC CENTIMETRE, LITRE, MILLILITRE, CUBIC METRE

1. The cubic centimetre (cm³)

A. DEVELOP A FEELING FOR THE CUBIC CENTIMETRE

1. Pick up a colored plastic cube. Measure its length, height, and width in centimetres.

THAT IS ONE CUBIC CENTIMETRE!

2. Find the volume of the litre box.

- a. Measure the length and width of one of the squares on the litre box in centimetres. Length _____ cm, width _____ cm.
- b. Measure the length, width and depth of the litre box in centimetres, and count the squares. Length _____ cm, number of squares _____; Width _____ cm, number of squares _____; Depth _____ cm, number of squares _____.
- c. Place a ROW of cubes against the bottom row of the front of the litre box. How many CUBES fit in the row? _____
- d. Place the ROW of cubes against the squares on the side of the box. How many ROWS would fit in the bottom layer of the box? _____
 How many CUBES in each row? _____
 How many CUBES would fit in the box altogether? _____
- e. Stand the ROW of cubes up against the side of the box. How many LAYERS would fit in the box? _____
 How many CUBES in each layer? _____
 How many CUBES would fit in the box altogether? _____

THE LITRE BOX WILL HOLD _____ CUBIC CENTIMETRES:

B. DEVELOP YOUR ABILITY TO GUESSTIMATE WITH CUBIC CENTIMETRES

You are now ready to develop your ability to estimate--to make a reasonable guess.

1. For each item below;

First, Estimate and write down how many cubic centimetres would fit in the space used by the object, or the space inside the object. Second, measure and multiply to find the Measurement. Third, decide how close you were. If your Estimate is within 25% of the Measurement, you are a "METRIC MARVEL!"

2. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Index card file box	_____	_____	_____
2. Freezer container	_____	_____	_____
3. Paper clip box	_____	_____	_____
4. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH CUBIC CENTIMETRES

1. Box of staples	_____	_____	_____
2. Book	_____	_____	_____
3. Package of paper	_____	_____	_____
4. Cardboard box	_____	_____	_____

II. The litre (l)

A. DEVELOP A FEELING FOR THE LITRE

1. Take a one litre beaker and fill it with water.
2. Pour the water into paper cups or drinking glasses, filling each as full as you usually do.
How many cups or glasses did you fill? _____

THAT IS HOW MUCH IS IN ONE LITRE!

3. Fill the litre box with rice.

THAT IS HOW MUCH IT TAKES TO FILL A ONE LITRE CONTAINER!

4. Take a litre beaker and fill it with 1 litre of water.
5. Pour the water into a large jug, bottle or freezer container.

THAT IS HOW MUCH SPACE ONE LITRE WILL FILL!

B. DEVELOP YOUR ABILITY TO GUESSTIMATE WITH LITRES

You are now ready to develop your ability to estimate--to make a reasonable guess.

To write two and one-half litres, you write 2.5 l

To write one-half litre, you write 0.5 l

To write two and three-fourth litres, you write 2.75 l

There are 1000 millilitres in 1 litre.

Half a litre is 500 millilitres (ml)

1. For each item below;

First, Estimate and write down how many litres you think it is.
Second, fill the container to the level you usually would. Measure how much it holds with a litre measure. Write the Measurement.
Third, decide how close you were.

2. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Medium-size freezer container	_____	_____	_____
2. Large freezer container	_____	_____	_____
3. Small freezer container	_____	_____	_____
4. Bottle or jug	_____	_____	_____
5. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH LITRES

1. Milk carton	_____	_____	_____
2. Soda bottle or can	_____	_____	_____
3. Mixing or serving bowl	_____	_____	_____
4. Sauce pan	_____	_____	_____

III. The millilitre (ml)

A. DEVELOP A FEELING FOR THE MILLILITRE

1. Examine a centimetre cube. A container which will hold 1 cubic centimetre will hold 1 millilitre.

2. Fill a 1 millilitre measuring spoon with rice.
Empty it into your hand.
Carefully pour it into a small pile on a sheet of paper.

THAT IS HOW MUCH 1 MILLILITRE IS!

3. Fill the 5 millilitre spoon with rice.
Pour it into another pile on the sheet of paper.

THAT IS 5 MILLILITRES OR ONE TEASPOON!

4. Fill the 15 millilitre spoon with rice.
Pour it into another pile on the sheet of paper.

THAT IS 15 MILLILITRES OR ONE TABLESPOON!

THESE TWO MEASURES STAY THE SAME SIZE.

5. Fill the 100 millilitre beaker with 100 ml of water.

THAT IS HOW MUCH 100 MILLILITRES IS!

- B. DEVELOP YOUR ABILITY TO GUESSTIMATE WITH MILLILITRES
You are now ready to estimate with millilitres.

1. For each of the items below;

First, Estimate and write down how many millilitres you think it will hold.
Second, fill it and measure it with a millilitre measure. Write the Measurement.
Third, decide how close you were.

2. If you have time, find other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Small juice can	_____	_____	_____
2. Paper cup or tea cup	_____	_____	_____
3. Soft drink can	_____	_____	_____
4. Bottle	_____	_____	_____
5. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH MILLILITRES

1. Small handful of rice	_____	_____	_____
2. Milk carton	_____	_____	_____
3. Bottle cap	_____	_____	_____
4. Jar	_____	_____	_____

IV. The cubic metre (m^3)

A. DEVELOP A FEELING FOR THE CUBIC METRE

A cubic metre is one metre long, one metre wide, and one metre high.

1. Place a 1 metre square on the floor next to a wall.
2. Measure 1 metre up the wall.
3. Picture a box that would fit into the space.

THAT IS THE VOLUME OF 1 CUBIC METRE.

4. Place a metre stick next to the table.
Remember how far the end was above the table.
Place a metre stick across the width of the table.
Remember how far the end was past the table.
Measure the table length in metres.
Picture how many cubic metres would fit into the space used by the table. _____ m^3

B. DEVELOP YOUR ABILITY TO GUESSTIMATE

1. For each of the items below;

First, Estimate and write down how many cubic metres you think it is.
Second, measure and multiply the length times width times height.
Write down the Measurement.
Third, decide how close you were.

2. If you have time, find other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Office desk	_____	_____	_____
2. File cabinet	_____	_____	_____
3. Other <u>Column</u> (<u>Brick Pier</u>)	_____	_____	_____

C. EXTRA PRACTICE WITH CUBIC METRES

1. Locker	_____	_____	_____
2. Closet or storage space (Janitor's Room)	_____	_____	_____
3. Small room (Vestibule)	_____	_____	_____
4. Large laboratory or shop equipment (Dishwasher room- use outside measurements)	_____	_____	_____

NOW YOU ARE READY FOR THE "VOLUME" MEASUREMENT IN EXERCISE NO. 1. CHOOSE THE UNIT OF VOLUME TO USE FOR EACH MEASUREMENT. THEN ESTIMATE AND FIND THE ACTUAL MEASUREMENT.

MASS RESOURCE TABLE

KILOGRAM, GRAM

Kilo = 1000

The symbol for gram is g

The symbol for kilogram is kg

There are 1000 grams in one kilogram.

1000 g = 1 kg

Half a kilogram can be written as 500 g or 0.5 kg

A quarter of a kilogram can be written as 250 g or 0.25 kg

Two and three-quarter kilograms is written as 2.75 kg

I. The kilogram (kg)

A. DEVELOP A FEELING FOR THE MASS OF A KILOGRAM

Using the balance or scale, find the mass (weight) of the items on the table. Notice how heavy the object "feels" and compare it to the reading on the scale or balance.

	<u>Mass (weight)</u>
1. 1 kilogram box	_____
2. Text book	_____
3. Bag of sugar	_____
4. Package of paper	_____
5. Your own mass	_____
6. Other _____	_____

B. DEVELOP YOUR ABILITY TO GUESSTIMATE IN KILOGRAMS

- Remember the mass of a kilogram.
- For the following items;

First, estimate the mass (weight) of the object and write down your answer in the Estimate column.

Second, use the scale or balance and find the mass of the object.

Third, decide how close your estimate is. If you are within 25% of the measurement, you are a "METRIC MARVEL."

- If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Bag of rice	_____	_____	_____
2. Bag of nails	_____	_____	_____
3. Large purse or briefcase	_____	_____	_____
4. A neighbor	_____	_____	_____
5. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH KILOGRAMS

1. A few books	_____	_____	_____
2. Chair	_____	_____	_____
3. Box of supplies	_____	_____	_____

II. The gram (g)

A. DEVELOP A FEELING FOR THE GRAM

1. Take a colored plastic cube, hold it in your palm.
 - a. Shake the cube in your hand as if shaking dice
 - b. feel the pressure on your hand when the cube is in motion, then when it is at rest.

THAT IS HOW HEAVY A GRAM IS!

2. Take a second cube and attach it to the first.
 - a. Shake the cubes in each hand
 - b. rest the cubes on the tips of your fingers, moving your hand up and down.
3. Take a third cube and place it on your hand.
 - a. Shake them around in your hand comparing the mass of one gram with the mass of two grams.

THAT IS THE DIFFERENCE BETWEEN ONE AND TWO GRAMS!

4. Take 5 more cubes and attach them together.
 - a. Place them in your hand and shake them around
 - b. rest them on the tips of your outstretched fingers.

THAT IS THE MASS OF FIVE GRAMS!

B. DEVELOP YOUR ABILITY TO GUESSTIMATE IN GRAMS

You are now ready to develop your ability to estimate—to make a reasonable guess.

1. Remember how heavy the 1 gram cube is, how heavy the two gram cubes are, and how heavy the five gram group is; or compare them again to the mass of the thing you are measuring.

2. For each of the following items;

First, write down your Estimate.

Second, find its mass on a scale.

Third, decide how close your estimate is. If you are within 25% of the measurement, you are a "METRIC MARVEL."

3. If you have time, find some other things to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Two thumb tacks	_____	_____	_____
2. Pencil	_____	_____	_____
3. Two-page letter and envelope	_____	_____	_____
4. Nickel	_____	_____	_____
5. Apple	_____	_____	_____
6. Package of margarine	_____	_____	_____
7. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH GRAMS

1. Key	_____	_____	_____
2. Watch	_____	_____	_____
3. Ring	_____	_____	_____
4. Ruler or metre stick	_____	_____	_____

NOW YOU ARE READY FOR THE "MASS" MEASUREMENT IN EXERCISE NO. 1. CHOOSE THE UNIT OF MASS TO USE FOR EACH MEASUREMENT. THEN ESTIMATE AND FIND THE ACTUAL MEASUREMENT.

TEMPERATURE RESOURCE TABLE

DEGREE CELSIUS

Degree Celsius ($^{\circ}\text{C}$) is the metric measure for temperature for everyday use.

A. DEVELOP A FEELING FOR DEGREE CELSIUS

Take an indoor/outdoor Celsius thermometer. Look at the marks on it.

1. Find 0 degrees.

WATER FREEZES AT ZERO DEGREES CELSIUS (0°C).

2. Find 100 degrees.

WATER BOILS AT 100 DEGREES CELSIUS (100°C).

3. Find the temperature of the room. _____ $^{\circ}\text{C}$
Is the room cool, warm or about right? _____
A comfortable temperature outside might be about _____ $^{\circ}\text{C}$.
4. Put some hot water from the faucet into a container with the thermometer.
Find the temperature. _____ $^{\circ}\text{C}$
Dip your finger quickly in and out of the water. Is the water very hot, hot or just warm? _____
5. Put some cold water in a container with the thermometer.
Find the temperature. _____ $^{\circ}\text{C}$
Dip your finger into the water.
Is it cool, cold or very cold? _____
6. Bend your arm at the inside of you elbow around the bottom of the thermometer or a clinical thermometer; or hold your hand against the bottom of the glass. After about three minutes, find the temperature. _____ $^{\circ}\text{C}$
Your skin temperature will not be as high as your body temperature.

NORMAL BODY TEMPERATURE IS 37 DEGREES CELSIUS. (37°C)

A FEVER IS 39°C .

A VERY HIGH FEVER IS 40°C .

B. DEVELOP YOUR ABILITY TO GUESSTIMATE IN DEGREE CELSIUS

You are now ready to develop your ability to guesstimate-- to make a reasonable guess.

For each item, Estimate and write down how many degrees Celsius you think it is. Then measure and write the Measurement. Then decide how close you were.

Page 1
Temperature

If your Estimate is within 25% of the Measurement, you are a "METRIC MARVEL!"

If you have time, find some other temperatures to measure.

	<u>ESTIMATE</u>	<u>MEASUREMENT</u>	<u>HOW CLOSE WERE YOU?</u>
1. Mix some hot and cold water in a container. Dip your finger into the water.	_____	_____	_____
2. Pour out some of the water. Add some hot water. Dip your finger <u>quickly</u> into the water.	_____	_____	_____
3. Outdoor temperature.	_____	_____	_____
4. Other _____	_____	_____	_____

C. EXTRA PRACTICE WITH DEGREE CELSIUS

1. Temperature at floor	_____	_____	_____
2. Temperature near ceiling	_____	_____	_____
3. Temperature near a light	_____	_____	_____
4. Mix of ice and water	_____	_____	_____
5. Boiling water	_____	_____	_____
6. Outdoor temperature at ground level	_____	_____	_____

Page 2
Temperature

SUGGESTED METRIC TOOLS AND DEVICES
 NEEDED TO COMPLETE MEASUREMENT TASKS
 (Objective 1)

Attachment #7

There is no single list of measuring devices that must be acquired by a school for the teaching of common units in the metric system. The following list is given for your consideration only. The items listed were selected from reliable suppliers and are readily available.

The following items will provide a teacher with the devices needed for completing the activities and exercises of objective one. Items marked with an asterisk (*) are optional and may be substituted by using another device. For example, a measuring tape attached to a wall can be used in place of a height measure.

Quantities are suggested for a class of twenty to twenty-five students. Here are some additional tips that may be helpful:

- Plan well in advance and consider all aspects of the use of the equipment.
- Look for metric equipment that is already in the school. Check with the math and science departments.
- Consider letting students design and construct some of the items. Also the advisability of converting old equipment for interim use.
- Stretch your budget. Prices differ among companies. Sometimes a local store is your best source. Multi-purpose items of good quality are worth considering.
- Improvise, where feasible, to save money, and often to improve the learning experience.

Activity	Quantity	Measurement Device	Supplier	Catalog No.	Price
Linear	✓ 10 - 12	Metre Stick	Blick	88006	2.90 ea.
			Brodhead	191009	2.89 ea.
			Ohaus	80010	2.95 ea.
	✓ 10 - 12	Rule, 30 cm	Blick	88029	4.90 pke of 10
			Ohaus	80080	.45 ea.
	✓ 10 - 12	Measuring Tape, 150 cm	Blick	88225	3.40 pke of 10
			Ohaus	80110	5.00 pke of 10
	✓ 1	*Height Measure	Blick	88039	15.80 ea.
		*Floor Stand for 88039	Blick	88040	8.60 ea.
	1	*Metre Tape, 10 metre	Blick	88013	6.90 ea.
Optional	1	Trundle Wheel	Ohaus	80130	9.95 ea.
			Blick	88042	9.30 ea.
	1	*Area Measuring Grid Transparent 25 cm x 25 cm Graph Paper, cm squares	Ohaus	80190	10.95 ea.
			Blick	88168	1.25 ea.



THE CENTER FOR VOCATIONAL EDUCATION

The Ohio State University • 1980 Kenny Road • Columbus, Ohio 43210

AGRI-BUSINESS AND NATURAL RESOURCES

* Ag. Sup. & Services	A D F G I J K N O
Ag. Production	A B E F I K N O
Ag. Mechanics	A B C D E I K N
Horticulture	A B E F I J K N O
Forestry	A I J K N O

* BUSINESS & OFFICE

Typists	*
Clerk-Typists	*
Gen. Office Clerks	*
Stenography	*
Key Punch Oper.	*

ARTS & HUMANITIES

Brdcast. Announcing	*
Theat. Costuming	N
Stg. Ltg. Tech.	*
Tech. Theat. Asst.	A B
Asst. Theat. Mgr.	A

* COMMUNICATION MEDIA

Type Composition	H N
Layout & Design	N
Copy Preparation	N
Off. Prt. Prs. Opr.	D K N
Litho Photography	H N
Offset Stripping	J K N
Offset Pltmaking	J K N
Bindery Operation	C
Comm. Photography	H N
Arch. Drafting	N O
Civil Drafting	F G K N O
Mech. Drafting	A C D

* CONSTRUCTION

Air Cond. & Refrig.	A H J K L N
Heating	A G L
Ventilating	A L
Plumbing	A F I K
Pipefitting	A K
Res. Electricity	A B D I
Indus. Electricity	A B D I
Comm. Electricity	A B D I

* HOME ECONOMICS

Child Care Aides	H N
Tailoring	*
Alter. Spec.	*
Homemkr & Health	G H
Food Preparation	H N O
Int. Des. Asst.	*
Bakers	H N O
Meat Cutting	N

ENVIRONMENTAL CONTROL

Wastewater Tech.

*

* HEALTH OCCUPATIONS

Nurses Aides	G K N
Nursing (RN)	G K N
LPN	G K N
Dental Assts.	G N
Diet. Techns.	*

* HOSPITALITY & REC.

Rec. & Tourism	F M N
Hotel & Lodging	M N
Food Services	N

* MANUFACTURING

Sht. Metal Wkng.	A B C D K
Welding & Cutting	A B C D K N
Tool & Die Mknq.	A B C D I
NC Operation	A C D E I
Metal Patternmknq.	A B I
Blueprint Rdg.	C D
Indus. Electronics	A B C D H I
Sm. Appl. Repair	A B D I
Maj. Appl. Repair	A B D H I O
Radio-TV Repair	A B D I
Audio Equip. Repair	A B D I

* MRKTING & DISTRIB.

Hd. Goods Merch.	*
Food Dist.	F N
Auto. Merch.	A B D E F I K N O
Petrol. Marketing	A B E F I K M N
Transportation	A F
Sft. Goods Merch.	*

* PERSONAL SERVICES

Cosmetology	N
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* TRANSPORTATION

Sm. Engine Repair	A B D E I K O
Diesel Mechanics	A B D G I K N
Auto Mechanics	A B D E I K N
Aviation Electrncls.	A B D I

PUBLIC SERVICE

Fire Service	F G
Law Enforcement	F

SUGGESTED METRIC TOOLS AND DEVICES
NEEDED TO COMPLETE MEASUREMENT TASKS
(Objectives 2 - 4)

Code
(See back side)

- A Assorted Metric Hardware. Hexagon Head cap screws, Hex nuts, washers, screws, cotter pins, etc.
- B Drill Bits. Individual bits or sets within the range of 1 mm to 13 mm.
- C Vernier Caliper. Pocket slide type with range to 120 mm.
- D Micrometer. Outside micrometer caliper with range of 0 to 25 mm.
- E Feeler Gage, Thickness gage with 13 blades and range of .05 to 1 mm.
- F Metre Tape. 50 or 100 metre tape for measuring long linear distances.
- G Thermometers. Special Purpose types used by students in certain occupational programs, such as a clinical thermometer used in the Health Occupations.
- H *Temperature Devices. Indicators used in a special application; ovens, freezing, cooling systems, etc.
- I Tools. Metric open end or Box wrench sets, socket sets, hex key sets.
- J Certain weather measuring devices. Rain gage, barometer, humidity, wind velocity indicators. (See package for specific needs)
- K *Pressure. Measuring devices for tire pressure, air, oxygen, hydraulic, fuel, etc.
- L *Velocity. Direct reading meter or vane type meter.
- M Road Map. State and city road maps.
- N Containers. Large non-metric containers for mixing and storing liquids; buckets, plastic containers, etc.
- O Containers. Large non-metric containers for mixing and storing dry ingredients; boxes, buckets, cans, etc.

Measuring devices currently are not available. Substitute devices (i.e. thermometer) may be used to complete the measurement task.

Most of the above items may be obtained from local industrial, hardware and school suppliers. For those who desire a listing of national suppliers, please contact a staff member of the Metric Education Project.

SUPPLIER'S LIST

Brodhead-Garrett Company
4560 East 7125 St.
Cleveland, OH 44105
(216)341-0248

Dick Blick Company
P.O. Box 1267
Galesburg, IL 61401
(309)343-6181

CAL Western Supply Co.
126 E. Graham Pl.
Burbank, CA 91502
(213)849-6711

Enrich, Inc.
3437 Alma St.
Palo Alto, CA 94306
(415)494-0150

Ohaus Scale Corporation
29 Hanover Rd.
Florham Park, NJ 07932
Ron Buck
(201)377-9000

*Terry M. Cervenka
280 Bridgewater Rd.
Trimble Run
Brookhave, PA 19015
(215)626-6644
(215)876-5958 (Home)

*Robert E. Vail Jr.
Box 4118
Foster City, CA 94404
(415)574-4430

Snap-On Tools Corporation
Kenosha, WI 53140
*Dick West
270 Glenmont Ave.
Columbus, OH 43214
(614)262-4726

*Bruce Gedder
1521 No. Placenta Ave.
Anaheim, CA 92806
(714)635-4550
(714)538-6710 (Home)

Stanley Tools
480 Myrtle St.
New Britain, CT 06050

L.S. Starrett Company
Athol, MA 01331
*Emanuel Manny Star
1710 Burning Bush Lane
Mt. Prospect, IL 60056
(312)297-8558

* Indicates a contact has been made by a member of the staff.

Lehigh County Vocational-Technical School
Metric Measurement Program
Reviewing Metric Precepts

Name: _____

Date: _____

Linear Measurement:

A. Provide or select the correct answers in these "thinking metric" problems:

1. The unit most appropriate for measuring the width of your living room is _____.
2. The unit most appropriate for measuring the length and width of a textbook is _____.
3. Distances between cities are given in _____.
4. Millimeters are most appropriate for measuring (a) cloth, (b) diameter of electrical wire, (c) length of a car.
5. The height of most adults is (a) less than 1 m, (b) between 1 and 1.5 m, (c) between 1.5 and 2 m, (d) more than 2 m.

Area:

A. Circle the correct answers in these "thinking metric" problems:

1. Which of the following would have an area of about 1 m^2 ?
(a) an envelope (b) a bed (c) a bedroom window (d) a watch crystal
2. 6 dm^2 might be the area of
(a) a workbook (b) a dollar bill (c) a postage stamp (d) a stick of gum
3. Which of the following would have an area of 1 cm^2 ?
(a) an ash tray (b) a newspaper (c) the iris of the eye (d) a door
4. A dollar bill would have an area nearer to
(a) 100 m^2 (b) 100 cm^2 (c) 100 dm^2 (d) 100 mm^2
5. The area of a quarter (25¢) is about
(a) 500 mm^2 (b) 500 cm^2 (c) 500 dm^2 (d) 500 ares

Volume:

A. Thinking Metric

1. A liter is a volume between the sizes of
(a) a basketball and volleyball (b) a volleyball and softball
(c) a softball and tennis ball (d) a tennis ball and ping pong ball
2. A cubic meter is about the volume occupied by a
(a) clothes hamper (b) television console (c) closet (d) refrigerator-freezer
3. Three cubic decimeters are the approximate volume of a
(a) large loaf of bread (b) shortening can (c) cereal box (d) brick
4. A tablespoon is equivalent to
(a) 1 ml (b) 9ml (c) 15 ml (d) 25 ml
5. A cubic centimeter is about the size of a
(a) marble (b) jar of paste (c) chalkboard eraser (d) pencil point

Metric Measurement Program
Reviewing Metric Precepts
Page 2

Mass:

A. Thinking Metric

1. A future Miss America might weigh about
(a) 23 kg (b) 54 kg (c) 80 kg (d) 112 kg
2. An object weighing about 25 grams is
(a) a silver dollar (b) a saucer
(c) a dinner plate (d) a telephone
3. A commodity most likely to be weighed in tonnes is
(a) marshmallows (b) gasoline
(c) lawn fertilizer (d) coal
4. A toothbrush weighs about
(a) 10 g (b) 50 g (c) 100 g (d) 250 g
5. An object which weighs about one gram is a
(a) ball point pen (b) bar of soap
(c) paper clip (d) can of soup

Temperature:

A. Circle the letter of the correct answer.

1. Temperature in the metric system is measured in
(a) centigrade degrees (b) centipede degrees (c) Celsius degrees
(d) seltzer degrees
2. A body temperature of 35°C would indicate a person is
(a) slightly chilled (b) normal (c) running a slight fever
(d) running a dangerously high fever
3. In cooperation with the government request that we lower the temperatures of our houses and offices, the thermostats should be set at
(a) 20°C (b) 25°C (c) 30°C (d) 35°C
4. The lowest temperature still suitable for comfortable swimming is about
(a) 18°C (b) 27°C (c) 35°C (d) 46°C
5. Bath water prepared for a baby should be no hotter than
(a) 20°C (b) 30°C (c) 40° (d) 55°C

LEHIGH COUNTY VOCATIONAL-TECHNICAL SCHOOL

METRIC WORKSHOP

Metric Units - Common and Uncommon

<u>Unit</u>	<u>Definition</u>	<u>Example Statement</u>
1. centimetre	unit of length	body size
2. degree celsius	unit for measuring temperature	room temperature
3. gram	unit of weight and mass	food portions
4. grams per square metre	unit of weight per area	fertilizer application
5. hectare	unit of area	building lot
6. joule	unit of work or energy	energy required to pump water
7. kilojoule	unit of work or energy	calorie-heating water
8. kilometre	unit of length	hauling distance
9. kilopascal	unit of pressure measurement	pressure gauge
10. kilowatt	unit of power	electric use
11. litre	unit of liquid volume	fuel tank
12. litres per second	flow of liquid, unit of volume	flow through a pipe
13. metric ton	unit of weight and mass	vehicle load limit
14. micrometre	unit of length	surface finishes
15. newton metre	unit of force	tightening spark plugs
16. square metre	unit of area	warehouse storage space
17. watt	unit of power	rating of a motor

LEHIGH COUNTY VOCATIONAL-TECHNICAL SCHOOL

METRIC WORKSHOP

U.S. Equivalents of Metric Units

METRIC SYSTEM ¹			
LENGTH			
unit	abbreviation	number of meters	approximate U.S. equivalent
myriameter	mym	10,000	6.2 miles
kilometer	km	1,000	0.62 mile
hectometer	hm	100	109.36 yards
dekameter	dam	10	32.81 feet
meter	m	1	39.37 inches
decimeter	dm	0.1	3.94 inches
centimeter	cm	0.01	0.39 inch
millimeter	mm	0.001	0.04 inch
AREA			
unit	abbreviation	number of square meters	approximate U.S. equivalent
square kilometer	sq km or km ²	1,000,000	0.3861 square mile
hectare	ha	10,000	2.47 acres
are	a	100	119.60 square yards
centare	ca	1	10.76 square feet
square centimeter	sq cm or cm ²	0.0001	0.155 square inch
VOLUME			
unit	abbreviation	number of cubic meters	approximate U.S. equivalent
dekastere	das	10	13.10 cubic yards
stere	s	1	1.31 cubic yards
decistere	ds	0.10	3.53 cubic feet
cubic centimeter	cu cm or cm ³ also cc	0.000001	0.061 cubic inch
CAPACITY			
unit	abbreviation	number of liters	approximate U.S. equivalent
kiloliter	kl	1,000	1.31 cubic yards
hectoliter	hl	100	3.53 cubic feet
dekaliter	dal	10	2.84 bushels
liter	l	1	0.35 cubic foot
deciliter	dl	0.10	1.14 pecks
centiliter	cl	0.01	0.908 quart
milliliter	ml	0.001	1.057 quarts
			61.02 cubic inches
			6.1 cubic inches
			0.18 pint
			0.21 pint
			0.6 cubic inch
			0.338 fluidounce
			0.06 cubic inch
			0.27 fluidram
MASS AND WEIGHT			
unit	abbreviation	number of grams	approximate U.S. equivalent
metric ton	MT or t	1,000,000	1.1 tons
quintal	q	100,000	220.46 pounds
kilogram	kg	1,000	2.2046 pounds
hectogram	hg	100	3.527 ounces
dekagram	dag	10	0.353 ounce
gram	g or gm	1	0.035 ounce
decigram	dg	0.10	1.543 grains
centigram	cg	0.01	0.154 grain
milligram	mg	0.001	0.015 grain

¹ For metric equivalents of U.S. units see Weights and Measures table.

LEHIGH COUNTY VOCATIONAL-TECHNICAL SCHOOL

METRIC WORKSHOP

Metric Equivalents of U.S. Units

WEIGHTS AND MEASURES ¹			
UNIT	ABBR. OR SYMBOL	EQUIVALENTS IN OTHER UNITS OF SAME SYSTEM	METRIC EQUIVALENT
WEIGHT			
<i>avoirdupois</i>			
short ton		20 short hundredweight, 2000 pounds	0.907 metric tons
long ton		20 long hundredweight, 2240 pounds	1.016 metric tons
hundredweight	cwt		
short hundredweight		100 pounds, 0.05 short tons	45.359 kilograms
long hundredweight		112 pounds, 0.05 long tons	50.802 kilograms
pound	lb or lb av also #	16 ounces, 7000 grains	0.453 kilograms
ounce	oz or oz av	16 drams, 437.5 grains	28.349 grams
dram	dr or dr av	27.343 grains, 0.0625 ounces	1.771 grams
grain	gr	0.036 drams, 0.002285 ounces	0.0648 grams
<i>tray</i>			
pound	lb t	12 ounces, 240 pennyweight, 5760 grains	0.373 kilograms
ounce	oz t	20 pennyweight, 480 grains	31.103 grams
pennyweight	dwt also pwt	24 grains, 0.05 ounces	1.555 grams
grain	gr	0.042 pennyweight, 0.002083 ounces	0.0648 grams
<i>apothecaries'</i>			
pound	lb ap	12 ounces, 5760 grains	0.373 kilograms
ounce	oz ap or $\mathfrak{z}$	8 drams, 480 grains	31.103 grams
dram	dr ap or $\mathfrak{r}$	3 scruples, 60 grains	3.887 grams
scruple	s ap or $\mathfrak{s}$	20 grains, 0.333 drams	1.295 grams
grain	gr	0.05 scruples, 0.002083 ounces, 0.0166 drams	0.0648 grams
CAPACITY			
<i>U.S. liquid measure</i>			
gallon	gal	4 quarts (231 cubic inches)	3.785 liters
quart	qt	2 pints (57.75 cubic inches)	0.946 liters
pint	pt	4 gills (28.875 cubic inches)	0.473 liters
gill	gi	4 fluidounces (7.218 cubic inches)	118.291 milliliters
fluidounce	fl oz or f $\mathfrak{z}$	8 fluidrams (1.804 cubic inches)	29.573 milliliters
fluidram	fl dr or f $\mathfrak{r}$	60 minims (0.225 cubic inches)	3.696 milliliters
minim	min or $\mathfrak{m}$	$\frac{1}{60}$ fluidram (0.003759 cubic inches)	0.061610 milliliters
<i>U.S. dry measure</i>			
bushel	bu	4 pecks (2150.42 cubic inches)	35.238 liters
peck	pk	8 quarts (537.605 cubic inches)	8.809 liters
quart	qt	2 pints (67.200 cubic inches)	1.101 liters
pint	pt	$\frac{1}{2}$ quart (33.600 cubic inches)	0.550 liters
<i>British imperial liquid and dry measure</i>			
bushel	bu	4 pecks (2219.36 cubic inches)	0.036 cubic meters
peck	pk	2 gallons (554.84 cubic inches)	0.009 cubic meters
gallon	gal	4 quarts (277.420 cubic inches)	4.543 liters
quart	qt	2 pints (69.355 cubic inches)	1.136 liters
pint	pt	4 gills (34.678 cubic inches)	568.26 cubic centimeters
gill	gi	5 fluidounces (8.669 cubic inches)	142.066 cubic centimeters
fluidounce	fl oz or f $\mathfrak{z}$	8 fluidrams (1.7339 cubic inches)	28.416 cubic centimeters
fluidram	fl dr or f $\mathfrak{r}$	60 minims (0.216734 cubic inches)	3.5516 cubic centimeters
minim	min or $\mathfrak{m}$	$\frac{1}{60}$ fluidram (0.003612 cubic inches)	0.059194 cubic centimeters
LENGTH			
mile	mi	5280 feet, 320 rods, 1760 yards	1.609 kilometers
rod	rd	5.50 yards, 16.5 feet	5.029 meters
yard	yd	3 feet, 36 inches	0.9144 meters
foot	ft or'	12 inches, 0.333 yards	30.480 centimeters
inch	in or"	0.083 feet, 0.027 yards	2.540 centimeters
AREA			
square mile	sq mi or m ²	640 acres, 102,400 square rods	2.590 square kilometers
acre		4840 square yards, 43,560 square feet	0.405 hectares, 4047 square meters
square rod	sq rd or rd ²	30.25 square yards, 0.006 acres	25.293 square meters
square yard	sq yd or yd ²	1296 square inches, 9 square feet	0.836 square meters
square foot	sq ft or ft ²	144 square inches, 0.111 square yards	0.093 square meters
square inch	sq in or in ²	0.007 square feet, 0.00077 square yards	6.451 square centimeters
VOLUME			
cubic yard	cu yd or yd ³	27 cubic feet, 46,656 cubic inches	0.765 cubic meters
cubic foot	cu ft or ft ³	1728 cubic inches, 0.0370 cubic yards	0.028 cubic meters
cubic inch	cu in or in ³	0.00058 cubic feet, 0.000021 cubic yards	16.387 cubic centimeters

¹ For U.S. equivalents of metric units see Metric system table

Lehigh County Vocational-Technical School
Metric Measurement Program
Use of Metric Slide Rule

Attachment #10

Metric to Standard Conversion and Standard to Metric Conversion

Answers

1. 4 miles = _____ Kilometers	1. 6.4
2. 20 centimeters = _____ inches	2. 7.8
3. 3 meters = _____ yards	3. 3.29
4. 9 inches = _____ centimeters	4. 22.5
5. 2 meters = _____ feet	5. 6.5
6. 1.2 yards = _____ meters	6. 1.1
7. 20 square miles = _____ square kilometers	7. 52
8. 9 sq. Kilometers = _____ sq. miles	8. 3.45
9. 5 gal. = _____ liters	9. 18.8
10. 80 liters = _____ gal.	10. 21.4
11. 9 quarts = _____ liters	11. 8.5
12. 15.2 oz. = _____ grams	12. $43.1 \times 10 = 431$
13. 15.3 ft. = _____ meters	13. 4.7
14. 0.24 short tons = _____ metric tons	14. 0.218
15. 4 liters = _____ quarts	15. 4.24
16. 4 quarts = _____ liters	16. 3.8
17. 3 pounds = _____ grams	17. 1350
18. 5 grams = _____ ounces	18. 0.2
19. 20 kilograms = _____ pounds	19. 44
20. 100 pounds = _____ kilograms	20. 45.5
21. 4000 grams = _____ pounds	21. 8.8
22. 25 degrees Centigrade _____ Fahrenheit	22. 77
23. 68 degrees Fahrenheit = _____ Centigrade	23. 20
24. -15 degrees Fahrenheit = _____ degrees Centigrade	24. -26
25. -15 degrees Centigrade = _____ degrees Fahrenheit	25. 5

Course Outline Title Photographic Metrics

Unit # 1 Metric Temperature Measurement

Objective: Student will

- (a) Be able to use Celsius scale thermometer properly by reading correct temperature within 2°C.
- (b) Be able to mix photographic chemicals at the required temperatures, so that chemicals will be useful.
- (c) Have a general idea of each chemicals required temperatures and reference temperatures (body, freezing and boiling water)
- (d) Develop photographic film, using his chemicals correctly.

Texts and References:

Chemical Mixing Packages (Required temperatures on package)

Materials: Worksheet - Teacher made

Photographic chemicals (Developer, Stop, Fixer)
Celsius Scale Thermometers
Mixing Containers

Visual Aids:

Handout: Reference Temperatures and celsius scale thermometer (Teacher made)

Teaching Points:

1. Reference temperatures (Freezing and boiling water, body temperature)
2. Using Celsius Scale (use of thermometer)
3. Mixing chemicals correctly at desired temperatures
4. Temperature of developer
5. Temperature of stop bath
6. Temperature of fixer
7. Darkroom temperature
8. Reading thermometer correctly
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

12.

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Assignments:

Students will work individually through worksheet, mixing chemicals and reading temperatures on the thermometer. Then after worksheet is completed, the students will develop his film in his own chemicals.

Comments:

Evaluation: Student's photographic film is sent through the developing process with the chemicals mixed by the student. Outcome of developing film will determine if he used the thermometer correctly and mixed chemicals at desired temperatures.

Course Outline Title Small Engine Repair

Unit # Finding cylinder displacement - two stroke

Objective:

- A. Given a piston from any two stroke engine, the student will determine the engine's displacement.
- B. Given a piston from any two stroke motorcycle, the student will determine the yearly insurance premium.

Texts and References:

The Metric System and SI, Sargent-Welch Co.
How to Read Charts and Graphs, MacMillan Co.

Materials:

Motorcycle engine with cylinder head removed or bore X stroke dimensions of engine, vernier caliper or micrometer, metric ruler, schedule of insurance rates for motorcycles, calculator, filmstrip projector, screen, tape player

Visual Aids:

How to Read a Metric Micrometer	}	Filmstrip/cassettes, Sargent-Welch Co.
How to Read a Metric Vernier Caliper		
How to Read a Metric Ruler		

Teaching Points:

1. Pretest students' ability to multiply decimal numerals
2. Review multiplication of decimal numerals if necessary
3. Linear and Volume Measurement skills - use pages 3, 4, 7, 8 of Ohio State Packet
4. Show filmstrips (see visual aids above) for reinforcement
5. Observe students measuring piston; give individual instruction if necessary
6. Applying the formula $V = \pi r^2 h$
7. Students check their computations on calculator
8. Refer to insurance schedule to determine premium
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

12.

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Assignments:

Obtain specification sheets from local motorcycle dealer. Blot out the stated cylinder displacement. Students will determine displacements using the other information given on specification sheet.

Comments:

Make sure students make their measurements in centimeters since engine displacement is usually given in CC or l.

If specification sheets list bore and stroke in millimeters, have students convert to centimeters.

Course Outline Title Metric Measurement in Automotive Engine Servicing

Unit # 2.0 Crankshaft Measurement

Objective:

Using the metric measuring system and metric measuring tools provided, the student will measure and record diameter, roundness, and taper of all main bearing journal surfaces of an internal combustion, automotive engine crankshaft.

Texts and References:

1. The Modernized Metric System - Explained, J.J. Keller and Associates, Inc., 1976
2. ORS-8 @ .50 Neenah, Wisconsin, 54956
Information sheet provided by instructor

Materials:

Crankshafts
Micrometers
Record form
Pencil/pen

Visual Aids:

Micrometer model
Crankshaft journal mock-up

Teaching Points:

1. Concept - Centimeters and Millimeters
2. Proper use of micrometer as a measuring device
3. Use of record form to determine journal condition
4. Identification of four locations (per journal) for adequate measurement
5. Location of specifications for use as a reference standard in determination of journal condition
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

12.

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Assignments:

The student will measure, record, and make a determination of condition of all main bearing journals on crankshaft assigned by instructor.

Comments:

Students will work alone and may use instructor or information sheets for reference.

Course Outline Title Machine Part Measurement and Detail Drawing

Unit # _____

Objective:

To gain experience in metric linear measurement of a machine part.

Texts and References:

Drafting technology and practice, William P. Spence

Materials:

Metric scale
Machine part - supplied by instructor
Vellum
Drafting tools

Visual Aids:

Teaching Points:

1. Correct use of metric scale
2. Review of orthographic projection
3. Review of dimensioning
4. Review of drafting standards
5. Review of detail drawing procedures
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

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Assignments:

1. Obtain machine part from instructor.
2. Make three (3) view sketch of part.
3. Measure all features of part and record values on sketch.
4. Make a three (3) view orthographic drawing of part and dimension according to standard practice.
5. Submit completed drawing to instructor for evaluation of measurements and drafting practice.

Comments:

Course Outline Title Food Services

Unit # Measuring - "Grams" for trainable mentally retarded students

Objective:

Given a sample picture recipe, the student will measure the correct amount of ingredients with 100% accuracy

Texts and References:

None

Materials:

Teacher made worksheets
Picture recipes
Ingredients
Measuring utensils

Visual Aids:

Teacher made transparencies
Teacher demonstrations
Sound-slide tapes (reinforcement activity)

Teaching Points: (Short term objectives)

1. Given an example of gram weight, the student will select items from a group, that are comparable in weight.
2. Given a predetermined number of grams, the student will measure the amount.
3. Given a recipe (picture) with multiple measurements, the student will measure the amounts into separate containers.
4. Given a picture recipe with multiple measurement, the student will measure the amounts into one container to make recipe.
5.
(Prerequisites for measuring grams)
6. The student must be able to:
 1. Count to 454 (equiv. of 1 lb.)
 2. Read a simple picture recipe (words, numbers etc.)
 3. Pour
 4. Do MTM basic movements
- 7.
- 8.
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

12.

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Assignments:

None

Evaluation - The student will make a simple recipe, using metric measurement (grams) with 100% accuracy as determined by the teacher.

Comments:

Course Outline Title Metrics for Cosmetology

Unit # 1 Metrics in Terms of Linear, Area, Volume, Mass and Temperature

Objective:

Students will become familiar with the above mentioned terms and be able to equate these terms into Metric measurement with a 100% accuracy at the end of this unit.

Texts and References:

A,B,C, of Metrics - XYZ Company, T.U., USA

Handouts (formulated by teacher to cover and reemphasize lecture and demonstration)

Materials:

Texts, metric stick, metric ruler, cubes, liquids, thermometers, measures for volumes - 10cm^3 - litre

Visual Aids:

Transparancies, movie, various objects i.e. Maniquin, scissors, pins, cosmetics, solutions, cubes (10cm^3)

Teaching Points:

1. Define Metric system
2. History of metrics - its relationship to American Measurement
3. Film on Metrics (Think Metric)
4. Film discussion
5. Demonstration of metrics in terms of Linear, Area, Volume, Mass and Temperature
6. Student demonstration for each area
7. Student exercises to be carried out in each area using materials, tools, equipment used in cosmetology
8. Test and evaluation
9. Review where necessary
10. Pretest if necessary
11. Further exercises if necessary

Teaching Points: (cont'd)

12. Think Metric

13.

14.

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20.

Assignments:

Measure in terms of the proper metric measurement:

Length:

Palm width
Patrom Height
Height of chairs at work station
length of rollers, shears
length of clipped hair shaft

Mass:

Yourself
Quantity of cotton in box

Temperature:

Tipid water
Warm
Permanents
Coloring - bleaches

Area:

Operators work station
Mirror at work station

Volume:

Bottle of shampoo
Cup
Curler applicator
Basin

Comments:

A thorough review of the unit and exercises -

Stress: Thinking & Picture Metrics!

Have a question answer session along with students giving demonstration

Course Outline Title Metrics for Food Preparation

Unit # 1 Measuring ingredients

Objective:

To be able to select the appropriate unit to measure various amounts of ingredient.

To know what tool to use for measuring liquid, dry or plastic foods.

Texts and References:

Metrics A Resource Guide for Home Economics - by Ruth Anderson

Metrics in the Kitchen - by Mary Darling

Materials:

Metric scales
Volume measuring containers
Ingredients
Slide rule of conversions

Visual Aids:

Equivalent charts to show relationship of known measuring devices to metric measurements.

Teaching Points:

1. Introduce metric units and prefixes
2. Show relationship between volume and mass
3. How to read tools
4. How to indicate weights and measurements (proper notations)
5. Estimate volume and mass of amounts of food
6. Convert a recipe to metric measurements
7. Expressing servings (portion sizes) in metric
- 8.
- 9.
- 10.
- 11.

Teaching Points: (cont'd)

12.

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Assignments:

Read appropriate pages in text books.

Measure liquid and dry ingredients by two methods (liters and grams). Students should compare milliliters of dry ingredients to the actual mass of that ingredient.

Convert a recipe into metric measurements.

Comments:

(This lesson extends over a week of classes)

Final project - prepare the simple recipe - evaluate final product for quality.

METRIC WORKSHOP EVALUATION

Name _____ School _____ Date _____

We desire to make this training program as meaningful and helpful as we can. We earnestly solicit your evaluation of this workshop and gladly welcome your comments and suggestions. Your comments will guide us in planning future workshops. Please answer the questions below.

1. How would you rate the following:	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>Unsatisfactory</u>
a. Organization of the workshop	_____	_____	_____	_____	_____
b. Adequacy of facilities	_____	_____	_____	_____	_____
c. Quality of presentations	_____	_____	_____	_____	_____
d. Adequacy of course materials	_____	_____	_____	_____	_____
e. Adequacy of hands-on devices	_____	_____	_____	_____	_____
f. Quality of films	_____	_____	_____	_____	_____
g. Adequacy of course content to my needs	_____	_____	_____	_____	_____

2. If any factor is rated "poor" or "unsatisfactory," please provide an explanation.

3. Do you feel the training you received adequately prepared you to teach metric measurement? Yes _____ No _____

4. Please assess your knowledge of the five units in the metric package developed by the Center for Vocational Education.

Level of Competency . . .	<u>High</u>	<u>Average</u>	<u>Low</u>
a. in working with linear, area, temperature, mass and volume.	_____	_____	_____
b. with metrics in your occupation or program.	_____	_____	_____
c. in metric-metric-equivalents.	_____	_____	_____
d. in selecting and using metric instruments, tools and devices.	_____	_____	_____
e. in working with metric conversion tables, ordering, selling and using products and supplies.	_____	_____	_____

Recommendations for Improving the Workshop

Scoring: Each correct answer is worth one point.
Total possible score = 60

Name _____

METRIC MEASUREMENT TEST

1. Please match the measuring units on the left with the use statements on the right.

<u>Unit</u>	<u>Statement</u>
a. degree Celsius	_____ flow through a pipe
b. gram	_____ building lot
c. micrometre	_____ food portions
d. kilometre	_____ body size
e. watt	_____ room temperature
f. litres per second	_____ energy required to pump water
g. hectare	_____ vehicle load limit
h. centimetre	_____ fertilizer application
i. metric ton	_____ surface finishes
j. grams per square metre	_____ hauling distance
k. newton metre	_____ tightening spark plugs
l. square metre	_____ warehouse storage space
m. joule	_____ rating of a motor
n. litre	_____ fuel tank

2. Which sentence is correctly typed?

- a. The hand cleaner is 178 gs. c. The paper is 216mm x 281 mm.
b. The mass of the package is 28 g. d. The car traveled 80 k/hour.

3. A 45° fillet weld 2 centimetres wide also has a width of:

- a. 20 millimetres b. 2 millimetres c. 0.2 millemetre d. 200 millimetres

4. Please match the metric replacement on the left with the following units on the right.

a. kilojoule	_____ feet
b. litre	_____ fluid ounce
c. metre	_____ pound
d. kilopascal	_____ pounds per square inch
e. millilitre	_____ gallon
f. kilowatt	_____ horsepower
g. kilogram	_____ calorie

5. Please match the measuring instruments on the left with the metric units on the right.

a. balance scale	_____ grams
b. pressure gauge	_____ kilopascals
c. tape	_____ centimetres
d. container	_____ millilitres
e. ruler	_____ hectares

6. A carpet 360 centimetres by 450 centimetres is also:

- a. 6 metres x 9 metres c. 3.6 metres x 4.5 metres
b. 36 metres x 45 metres d. 0.36 metre x 0.45 metre

7. The correct way to write twenty grams is:

- a. 20 gms b. 20 Gm. c. 20 g. d. 20 g⁹⁷

8. The equivalent of 2 m is about:

- a. 4 feet b. 7 feet c. 24 feet d. 200 feet

9. Estimate the length of the line segment below.

- a. 23 grams b. 6 centimetres c. 40 millimetres d. 14 pascals

10. Fill in the following chart.

millilitres (ml)	litres (l)	millilitres (ml)	litres (l)
3 000	3	700	()
6 000	()	()	0.9
()	8	250	()
14 000	()	()	0.47
()	23	275	()
300	()		

11. Use the conversion table to answer the following: mm in.

The equivalent of . . .

- a. 150 mm is how many inches _____
b. 210 mm is how many inches _____
c. 990 mm is how many inches _____

100	3.94
200	7.87
300	11.81
800	31.50
900	35.43
10	0.39
20	0.79
50	1.97
60	2.36

12. Please match the metric equivalents with the following:

- a. 2 m²
b. 1 m²
c. 1 kg
d. 1 mg
e. 5 ml
f. 1 cm
g. 1 mm
h. 5 g
i. 10 cm
j. 400 kJ

- _____ teaspoon
_____ energy value of an apple
_____ height of a doorway
_____ a cardtable top
_____ mass of a grain of salt
_____ width of a paper clip
_____ thickness of a dime
_____ mass of Webster's Collegiate Dictionary
_____ 4 inches
_____ mass of a nickel

13. When ordering material for your lab, what metric units are used for the following items:

- a. gasoline _____
b. carpet _____
c. leather clothing articles _____

- d. block solder _____
e. box of cotton _____

METRIC WORKSHOP EVALUATION

Attachment #14

Name SUMMARY-24 PARTICIPANTSchool Lehigh County AVTSDate July 13, 14,

1978

EVALUATIONS

We desire to make this training program as meaningful and helpful as we can. We earnestly solicit your evaluation of this workshop and gladly welcome your comments and suggestions. Your comments will guide us in planning future workshops. Please answer the questions below.

1. How would you rate the following:	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>Unsatisfactory</u>
a. Organization of the workshop	<u>20</u>	<u>4</u>	<u> </u>	<u> </u>	<u> </u>
b. Adequacy of facilities	<u>21</u>	<u>3</u>	<u> </u>	<u> </u>	<u> </u>
c. Quality of presentations	<u>7</u>	<u>15</u>	<u>2</u>	<u> </u>	<u> </u>
d. Adequacy of course materials	<u>18</u>	<u>5</u>	<u>1</u>	<u> </u>	<u> </u>
e. Adequacy of hands-on devices	<u>19</u>	<u>5</u>	<u> </u>	<u> </u>	<u> </u>
f. Quality of films	<u>18</u>	<u>6</u>	<u> </u>	<u> </u>	<u> </u>
g. Adequacy of course content to my needs	<u>8</u>	<u>13</u>	<u>2</u>	<u>1</u>	<u> </u>

2. If any factor is rated "poor" or "unsatisfactory," please provide an explanation.

3. Do you feel the training you received adequately prepared you to teach metric measurement? Yes 22 No 2

4. Please assess your knowledge of the five units in the metric package developed by the Center for Vocational Education.

Level of Competency . . .	<u>High</u>	<u>Average</u>	<u>Low</u>	<u>NA</u>
a. in working with linear, area, temperature, mass and volume.	<u>16</u>	<u>8</u>	<u> </u>	<u> </u>
b. with metrics in your occupation or program.	<u>8</u>	<u>13</u>	<u>2</u>	<u>1</u>
c. in metric-metric-equivalents.	<u>14</u>	<u>9</u>	<u>1</u>	<u> </u>
d. in selecting and using metric instruments, tools and devices.	<u>11</u>	<u>10</u>	<u>3</u>	<u> </u>
e. in working with metric conversion tables, ordering, selling and using products and supplies.	<u>11</u>	<u>8</u>	<u>5</u>	<u> </u>

Recommendations for Improving the Workshop